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Midwest Research Inst, Kansas City, Mo

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Industrial Environmental Research
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Research Triangle Park NC 27711

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May 1978

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16. ABSTRACT
The report addresses the selection of relevant factors to gain perspective of the pollution potential from pesticides manufacturing and formulating operations and leads to the evolvement and defense of decision criteria for assessing the need for development of emissions control technology. Pesticides manufacturing and formulating operations are treated as materials input/output systems, with chemical wastes identified for all media. From about 300 active pesticide ingredients, six candidates (representing five different chemical classifications) were chosen for detailed source assessment. The pesticides industry is characterized and quantified where possible, using available information. Data give a macroeconomic view of the pesticides manufacturing and formulating operations. Government regulatory pressure and posture is identified and assessed. Appendices contain much information on the pesticides industry from several viewpoints.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Waste Disposal	Pollution Control	13B
Pesticides	Effluents	Stationary Sources	06F
Manufacturing		Source Assessment	05C
Formulation		Pollution Potential	07A
Toxicity		Hazardous Materials	06T
Industrial Wastes			

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Industrial Environmental Research Laboratory
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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

PREFACE

This report presents the results of a project entitled, "Information Development on Pesticides Manufacturing for Source Assessment," performed by Midwest Research Institute (MRI) under Contract No. 68-02-1324, Task 43, MRI Project No. 3821-C(43) for the Industrial Environmental Research Laboratory, Research Triangle Park, of the U.S. Environmental Protection Agency (EPA). Mr. D. K. Oestreich has been the project officer for EPA.

The project was conducted from January 1 to April 30, 1976, by Mr. Thomas L. Ferguson, Senior Chemical Engineer, who served as project leader, Dr. Ralph R. Wilkinson, Associate Scientist, Mr. Gary L. Kelso, Associate Chemical Engineer, and Mr. J. R. Malone, Jr., Associate Socioeconomic Policy Analyst, under the supervision of Dr. E. W. Lawless, Head, Technology Assessment Section. Dr. R. von Rümker, RvR Consultants, was a consultant on this project.

MRI expresses its sincere appreciation to the many representatives of federal, state, and local agencies, and to the many companies who provided technical information for this report.

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SECTION 1

INTRODUCTION

In December 1975, Midwest Research Institute (MRI) was asked by the Industrial Environmental Research Laboratory, Research Triangle Park, (IERL-RTP), of the U.S. Environmental Protection Agency (EPA) to assist the Monsanto Research Corporation (MRC) of Dayton, Ohio, in assessing the need for emissions control technology development for the pesticide manufacturing industry. MRC was under contract to IERL-RTP to provide source assessments of air emissions for various segments of American industry including the pesticide industry.

The primary objectives and responsibilities of the MRI effort were:

- Provide support to MRC in identifying relevant factors for the development of decision criteria for establishing if a given pesticide manufacturing industry requires development of emissions control technology.
- Select, recommend, and defend by logical argument an initial list of the six individual pesticides (i.e., six pesticide manufacturing industries) most worthy of detailed source assessment regarding potential environmental insult.

Secondary objectives included the following:

- Review and update the 1972 MRI document, "The Pollution Potential in Pesticide Manufacturing" (Technical Studies Project TS-00-72-04; NTIS PB-213 782/3), regarding pesticide emissions data; pesticide active ingredient identification, production volume, and toxicity data; and quantifying, wherever possible, the information presented in the Summary Section.
- Identify and describe the roles of all government groups actively involved in the study of the pesticides manufacturing industry which could serve as sources of information pertaining to the need for development of emission control technology. Identify individuals within groups who might serve as possible interfaces.

- Identify and assess regulatory pressure and posture now in force as well as anticipated trends.

- Make available to MRC any data on pesticide manufacturing emissions (air, water, and solid waste) which MRI possesses.

Guidelines regarding the relevant factors for determining decision criteria for emissions control technology development for the pesticide manufacturing industries included, but were not limited to, the following:

1. Comparison of unacceptable human exposure from manufacturing emissions with that from field formulation and application.

2. Potential seriousness of exposure in terms of (a) acute health effects and (b) chronic health effects.

3. Potential for mobilization of pollutants from past waste disposal practices (e.g., leaching from buried waste), persistence, transportability, etc.

4. Comparison of environmental risks between manufacturing and formulating operations.

5. Availability of control technology.

Methodologies to accomplish the objectives within the guidelines previously given included contact with manufacturers and formulators of pesticides; contact with various governmental groups and agencies involved in the pesticide industry; an examination of recent technical and economic literature on pesticides including governmental documents; an examination of reports, documents, and files within MRI; and discussions with several knowledgeable persons having contact with MRI.

The early sections of the report are concerned with pesticides as economic poisons, the characterization and the quantification of the pesticides manufacturing industries. Data are offered in the form of tables, graphs, and charts to give a macroeconomic view of the pesticides manufacturing and formulating industries.

The body of the report first addresses the selection of relevant factors to gain perspective of the pollution potential from pesticide manufacturing and formulating operations and leads to the evolvement and defense of a set of factors for assessing the need for development of emissions control technology.

The body of the report next addresses the selection of candidate pesticides worthy of detailed source assessment. From a potential listing of some 1,200 pesticide active ingredients, a subset of six candidates worthy of detailed source assessment was chosen and defended.

The report closes with a section on governmental regulatory pressure and posture. Future trends likely to develop are assessed.

A series of appendices contains much information on the pesticide industry and the potential for pollution from several vantage points and indicates the pervasive nature of the pesticide data base.

SECTION 2

CHARACTERIZATION OF THE PESTICIDE INDUSTRY

PESTICIDE CLASSES

A broad definition of "pesticides" includes those chemicals or classes of chemicals used to control various kinds of pests in order to increase food and fiber production or to better free us from disease and objectionable plants, animals, and other organisms. Pesticides can be classified according to several organizing principles as will be seen below.

Pesticides are usually classified by the kind of pest they control, purpose of application, or a mode of action on a pest. Table 1 presents current general usage categories of pesticides.

Table 1. PESTICIDE CLASSES BY PURPOSE

- Algicides (A)
- Defoliants (DF)
- Dessicants (D)
- Fumigants (FU)
- Fungicides (F)
- Growth regulants--insect and plant (IGR, PGR)
- Herbicides (H)
- Insecticides (I)
- Larvacides (L)
- Miticides (acaricides) (M)
- Molluscicides (MO)
- Nematocides (N)
- Pheromones (attractants) (P)
- Repellants (R)
- Rodenticides (RO)
- Sterilants (S)
- Synergists (SN)

The above classification is not mutually exclusive. A pesticide active ingredient may be useful for controlling more than one type of pest; e.g., aminocarb, a carbamate, can be classified by (I, M, MO); DBCP, a halogenated hydrocarbon by (FU, N); endrin, a halogenated aromatic compound by (I, RO); Vapam®, a dithiocarbamate by (F, H, N).

Pesticides are often classified to reflect aspects of their chemistry. The Mrak Commission Report,[1] for example, grouped all pesticides into eight major types according to their biological activity (i.e., insecticides and miticides; fungicides and bactericides; herbicides, defoliants, and dessicants; nematocides; rodenticides and mammalian biocides; molluscicides; piscicides;

and avicides) but identified about 45 subgroups based on chemical structure or origin. In another study, 550 pesticidal chemicals were classified into seven major groups with 44 subgroups according to those aspects of their chemical structures that were pertinent to disposal of unused pesticides.[2] A 1972 study of the pollution potential in pesticide manufacturing considered not only the chemical structures and properties of pesticides but also the production volumes of various use or structure categories in order to select representative pesticides.[3] A 1975 study of the pesticide industry grouped pesticides into 12 industrial segments according to chemical structures and reactions.[4]

In the present study, we have found it most convenient to categorize pesticides primarily according to the production process chemistry. Eleven categories have been adopted as shown in Table 2 and have been ordered to reflect to a substantial degree the production volumes of the various categories. This classification will be discussed in more detail in subsequent sections.

MANUFACTURING AND FORMULATING OPERATIONS

The pesticides industry includes manufacturers of active ingredients (who may also formulate pesticide products) and formulators who combine active ingredients with other substances to yield pesticide products. Both activities involve packaging and shipping. Both activities are possible sources of toxic pollutants.

It is essential to distinguish clearly between manufacturers and formulators of pesticides. The pesticide manufacturer takes raw materials (industrial chemicals and intermediates) and by relatively low energy processes (compared to energy intensive industries such as the metallurgical industry) transforms them into active ingredients. By-products, intermediates, and wastes are significant factors in the manufacturing process and each can contribute to the overall pollution potential of the process. In some cases, the raw materials or wastes are as hazardous as the desired product.

The formulator combines, primarily through simple mixing or blending operations, the active ingredient with other materials (e.g., surfactants, clays, powders, solvents, etc.) to yield the pesticide formulation. In essence, the formulator dilutes the active ingredient or renders it more convenient for handling and use by the consumer.

The formulator usually has no intermediates or by-products and few wastes unless an error occurred in the formulation process. Wastes result regularly from cleanup of process equipment, tank cars, and container disposal. Occasionally, off-specification products are obtained because of improper mixing or blending, contamination from a previous mixing operation, off-specification active ingredient or other ingredients, packaging problems, etc. If an

Table 2. CHEMICAL CLASSIFICATION OF PESTICIDES

	Classification	Examples
I.	Chlorinated hydrocarbons	DDT, toxaphene
II.	Organophosphates	
	Phosphates	Monocrotophos
	Phosphorothioates	Methyl parathion Fensulfothion
	Phosphorodithioates	Malathion Merphos
III.	Carbamates	
	Carbamates	Carbaryl, Bux®
	Thiocarbamates	EPTC, vernolate
	Dithiocarbamates	Maneb, zineb
IV.	Triazines	Atrazine Simazine
V.	Anilides	Propachlor Alachlor
VI.	Organoarsenicals and organometallics	MSMA, DSMA Copper naphthenate
VII.	Other nitrogenous compounds	Captan Maleic hydrazide
VIII.	Diene-based	Chlordane Endrin
IX.	Ureas and Uracils	Bromacil Diuron
X.	Nitrated hydrocarbons	Trifluralin Chloropicrin
XI.	Miscellaneous category	
	Bacterial	*B. thuringiensis*
	Viral	Elcar®
	Pheromones	Disparlure®
	Growth regulators (insect and plant)	Altosid IGR®
	Other synthetic organics	Methyl bromide

off-specification product cannot be reworked or reblended with other acceptable products, the pesticide product becomes waste and must be handled and disposed of properly. Thus, a pollution potential exists for each type of operation.

PRODUCTION QUANTITIES AND NUMBERS OF PESTICIDES AND FORMULATED PRODUCTS

The 1974 production volumes of all synthetic organic pesticides have been estimated on this program. The results for the major synthetic organic pesticide groups and individual pesticides show that about 1.42 billion pounds of pesticide active ingredients (AI) were produced in 1974, consisting of 37 major pesticides (those produced in volumes of 10 million pounds or more), which accounted for a combined production of 1.04 billion pounds or 74% of the market. The remaining 26% was divided among about 300 other pesticides. A total of 140 to 150 synthetic organic pesticides are estimated to have had production volumes in excess of 1 million pounds in 1974.

The Stanford Research Institute Directory of Chemical Producers indicates that approximately 50 pesticide active ingredients can also be classified as industrial chemicals, e.g., acrolein, formaldehyde, sulfur, etc.[5] These are identified in Appendix A and are considered to be outside the scope of work since their main usage lies in the nonpesticide areas.

EPA's Office of Pesticide Programs (OPP) has estimated that in 1975 there were 1,200 pesticide active ingredients registered for use in pesticide products. This estimate is based on the assumption that some active ingredients have multiple uses; the 1,200 estimate counts each active ingredient only once.[6]

These active ingredients are formulated in 23,633 different pesticide products (as of October 23, 1975) at 5,353 registered formulating plants (as of July 9, 1975) throughout the United States. These plants are registered as follows: 4,111, interstate; 1,023, intrastate; and 218, foreign. (Note: As of February 18, 1976, a total of 5,799 plants were engaged in the production and formulation of pesticides.)[7]

LOCATION OF PESTICIDE MANUFACTURERS AND FORMULATORS IN THE U.S.

EPA maintains a data base of pesticide manufacturers and formulators by region in the United States; this information is given in Table 3.[8]

The heaviest concentrations of pesticide manufacturers and formulators are in the Middle Atlantic States, the Great Lakes States, Florida, Texas, and California. Figure 1 presents the location of approximately 5,800 pesticide manufacturers and formulators, by state, as of February 18, 1976.

Table 3. MASTER LIST OF PESTICIDE MANUFACTURERS AND FORMULATORS IN THE U.S. BY EPA REGION

State	EPA Region I	II	III	IV	V	VI	VII	VIII	IX	X
Alabama				108						
Alaska										0
Arizona									55	
Arkansas						31				
California									625	
Colorado								69		
Connecticut	38									
Delaware			11							
District of Columbia			6							
Florida				421						
Georgia				291						
Hawaii									52	
Idaho										43
Illinois					302					
Indiana					125					
Iowa							162			
Kansas							81			
Kentucky				123						
Louisiana						111				
Maine	18									
Maryland			71							
Massachusetts	101									
Michigan					126					
Minnesota					104					
Mississippi				52						
Missouri							219			
Montana								20		
Nebraska							89			
Nevada									28	
New Hampshire	10									
New Jersey		259								
New Mexico						13				
New York		233								
North Carolina				150						
North Dakota								15		
Ohio					241					
Oklahoma						41				
Oregon										99
Pennsylvania			190							
Rhode Island	19									
South Carolina				57						
South Dakota								24		
Tennessee				166						
Texas						388				
Utah								16		
Vermont	3									
Virginia			95							
Washington										128
West Virginia			30							
Wisconsin					131					
Wyoming								9		
Puerto Rico		26								
Other possessions		0							0	
Total	189	518	403	1,368	1,029	584	551	153	760	270

Grand total establishments - 5,825
February 18, 1976

Grand total establishments in U.S. - 5,799

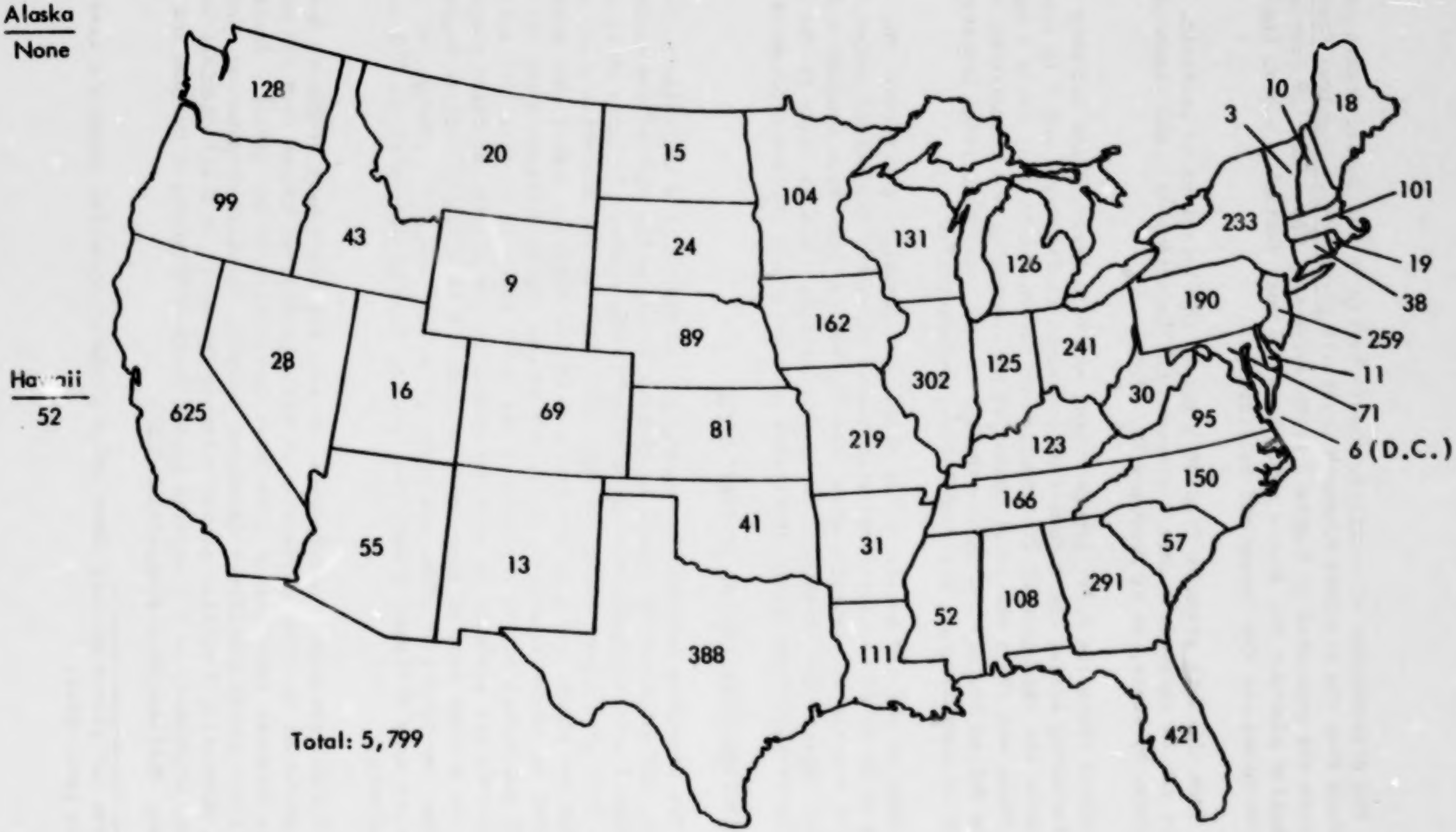
Alaska
None
Hawaii
52
128
99
43
20
15
104
131
126
233
18
10
3
101
19
38
259
11
71
6 (D.C.)
24
9
162
190
241
125
302
28
16
69
89
81
219
123
30
95
150
166
625
55
13
41
31
388
111
52
108
291
57
421
Total: 5,799

Figure 1. Location of pesticide manufacturers and formulators, by state, 1976.

The distribution of pesticide manufacturers in the United States can be obtained from the Stanford Research Institute Directory of Chemical Producers.[5] The data are presented in Figure 2 which shows that there are 139 pesticide production plants.* The states which have the most pesticide active ingredient manufacturers are New Jersey and California.

From the data given in Figures 1 and 2, the locations of pesticide formulators can be derived. Figure 3 presents the locations of 5,660 pesticide formulators, by state, as of February 18, 1976.

Since there are 5,799 manufacturing and formulating sites but only 139 manufacturing sites, the information contained in Figures 1 and 3 is similar and shows the same general distribution in the United States. Table 4 summarizes this data, and shows the total number of manufacturing and formulating sites in the United States, and the percentage of the total pesticides industry represented by manufacturers and formulators, respectively.

Many of the 139 manufacturing sites also formulate pesticides. The important point to be noted is that formulation sites represent the larger number of potential sources of pesticide emissions and wastes. This fact coupled with limited capital for investment in emission control devices leads to the overall conclusion that formulation operations have a serious pollution potential.

DISTRIBUTION OF PESTICIDES BY PLANT SITES

The preceding information regarding pesticide active ingredients, manufacturers, and sites can be recast to yield a distribution plot of the number of individual active ingredients in relation to the number of plants which produce them. This arrangement shows how many individual active ingredients are produced by only one plant, how many are produced by two separate plants, how many are produced by three separate plants, and so on. Figure 4 presents the distribution of 307 individual active ingredients and shows how many of these 307 active ingredients are produced by only one plant, by two plants, by three plants, etc. The obvious fact of importance is that 205 of these 307 active ingredients, or about two-thirds of them, are produced at only one plant (though, of course, there are many different plants that are the sole producers of the 205 active ingredients).

The 205 pesticides manufactured by sole producers vary widely in quantities produced. In 1974, production of these pesticides ranged from 110 million pounds atrazine (produced by Ciba-Geigy Corporation at St. Gabriel, Louisiana), 10 million pounds disulfoton (produced by Mobay Chemical Corporation, Kansas City, Missouri), 3 million pounds nitralin (produced by Shell Chemical Company, Denver, Colorado), to < 1 million pounds Perthane® (produced by Rohm and Hass Company, Philadelphia, Pennsylvania).[9]

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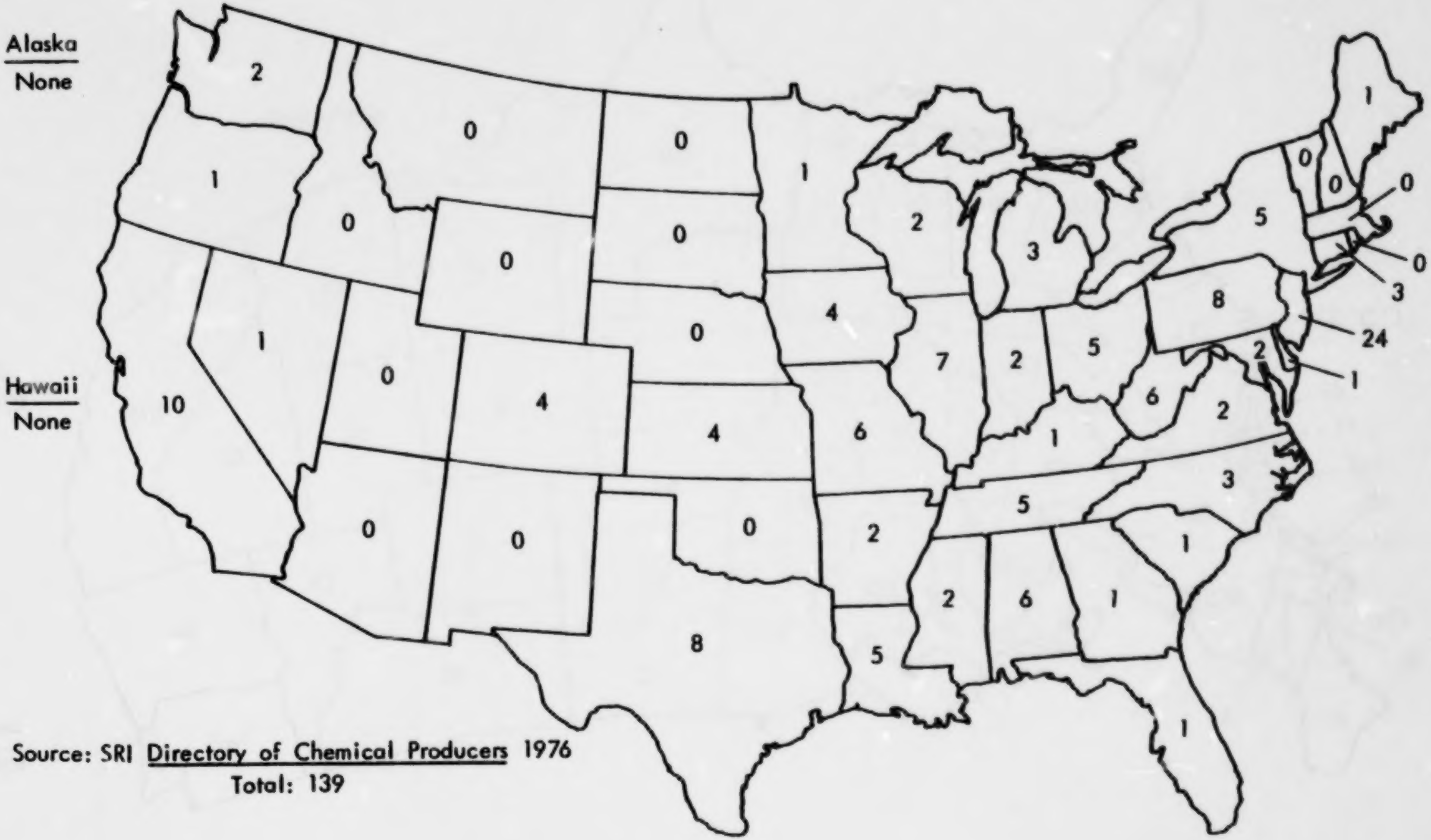
* These 139 plants exclude those which produce industrial chemicals also used as pesticides.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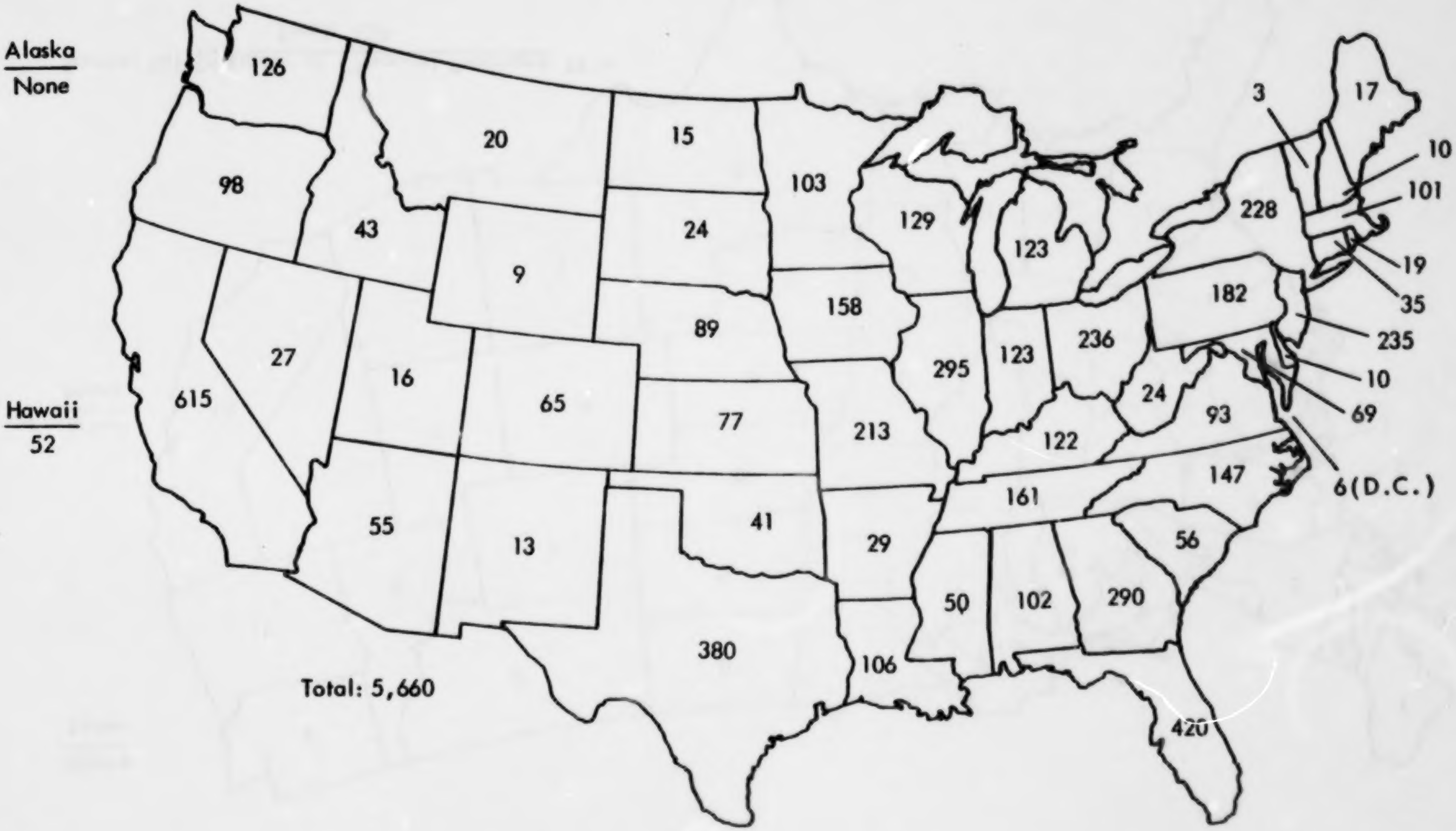
Source: SRI Directory of Chemical Producers 1976
Total: 139

Figure 2. Location of pesticide production plants, by state, 1976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235
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123
236
24
93
147
65
77
213
122
161
55
13
41
29
50
102
290
56
380
106
420
Total: 5,660

Figure 3. Location of pesticide formulators, by state, 1976.

TABLE 4. NUMBER OF PESTICIDE MANUFACTURING AND FORMULATION SITES

Type of pesticide plant	No.	Percent of pesticides industry
Manufacturer	139	2.4
Formulator	5,660	97.6
Total	5,799	100

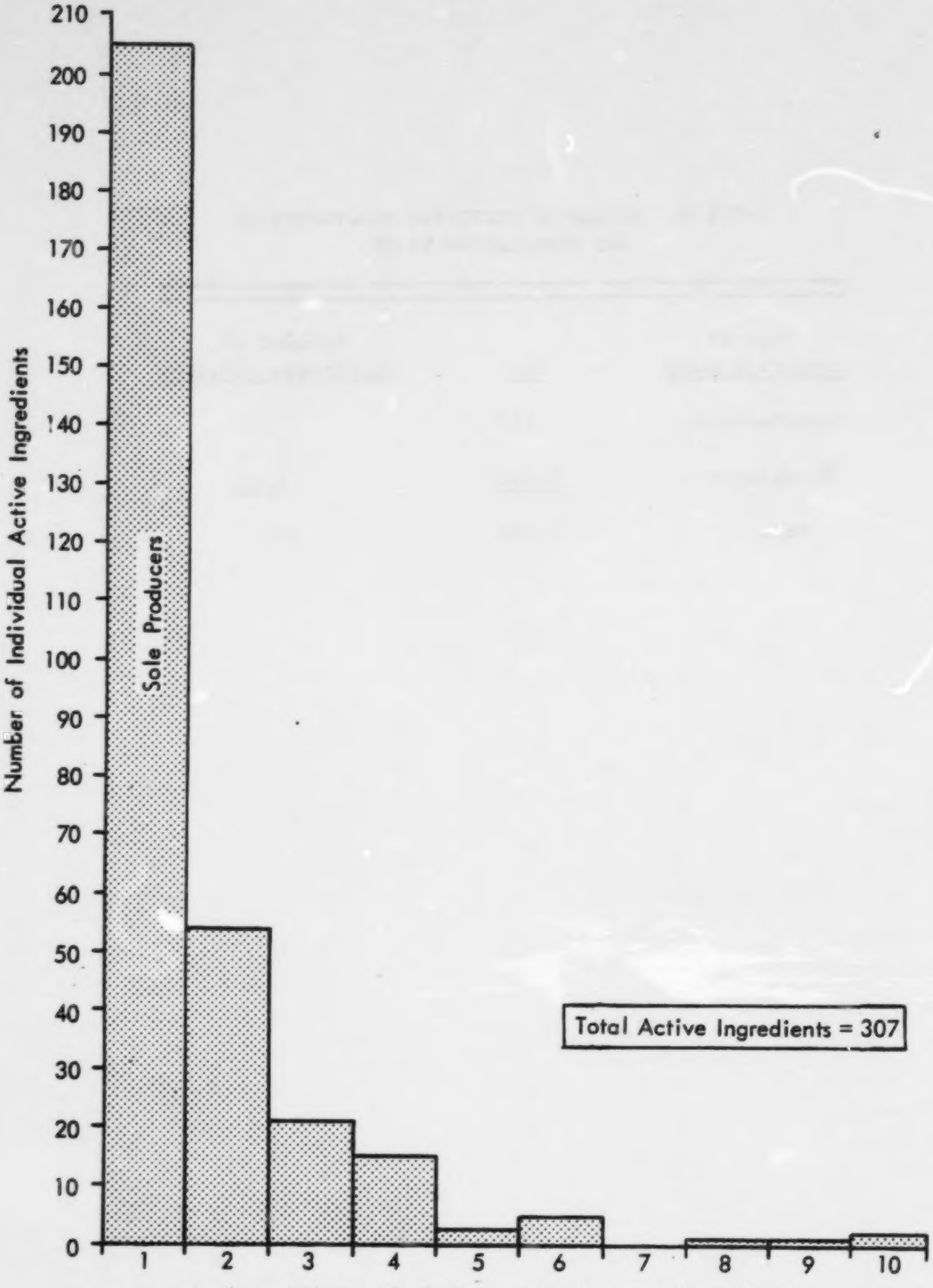


Figure 4. Distribution of the number of individual active ingredients produced at a specific number of plants.

Beyond the sole production sites shown in Figure 4 we find that 54 active ingredients are manufactured at two sites, 21 active ingredients at three sites, etc. There are two pesticides--(2,4-dichlorophenoxy)acetic acid, n-butyl ester and the corresponding iso-octyl ester--which are manufactured at 10 different locations each.

DISTRIBUTION OF PLANTS BY NUMBER OF PESTICIDES MANUFACTURED AT EACH PLANT

The same set of pesticide data by manufacturer and plant site can be used to illustrate the distribution of plants by the number of individual active ingredients manufactured at each plant site. Figure 5 presents this distribution and again it is immediately apparent that the vast majority of the plants produce only one or a few active ingredients. Thus, 59 plants produce only one pesticide active ingredient, and 26 plants produce only two. In contrast, Table 5 indicates those plants which produce a large number of different active ingredients.

These data must be qualified to the extent that the plants either manufacture a given active ingredient or have the capacity of manufacturing a given active ingredient. In general, pesticide companies do not simultaneously manufacture their entire product line but do have facilities for production of various active ingredients without extensive plant modification.

DISTRIBUTION OF PESTICIDE FORMULATIONS BY CHEMICAL CLASS AND TYPE OF FORMULATION

Distribution data regarding pesticide formulations by chemical class and formulation type are available from an earlier MRI report.[10] In particular, Figure 6 presents the distribution of the percentage of formulation plants by the number of chemical classes of pesticide active ingredients formulated. Approximately 80% of the large formulation plants utilize from one to three chemical classes of pesticide active ingredients. This fact may be interpreted as meaning that certain companies specialize in the manufacture and management of a limited number of product lines.

Figure 7 presents the distribution of the percentage of large formulation plants by the number of physical types of pesticides formulated (liquids, powders, dusts, granules, strips, baits, etc.). Approximately 62% of the large formulation plants produce only one physical type of pesticide formulation. In fact, nearly all (99+%) of the formulation plants handle only one to three physical types of formulations.

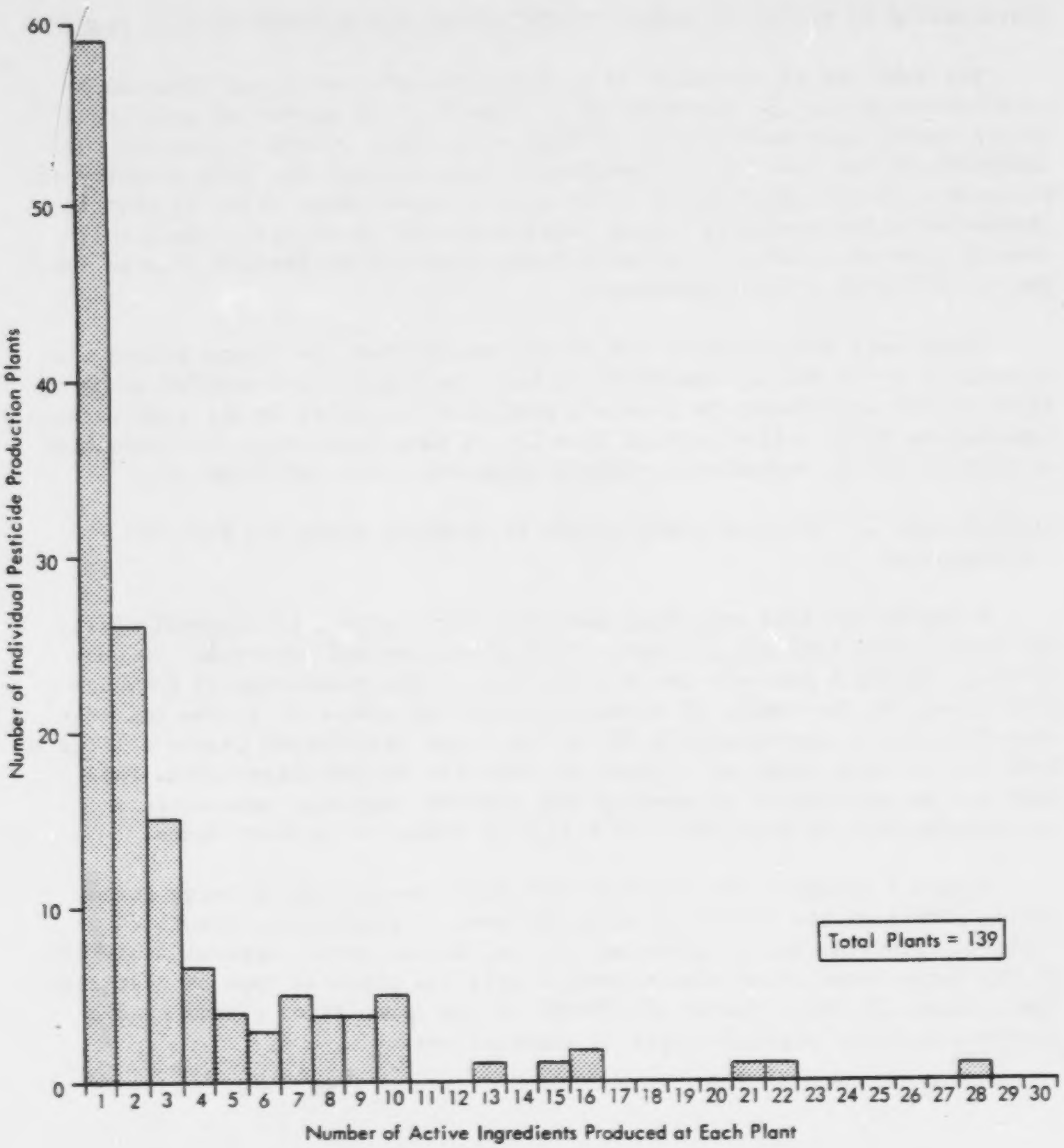
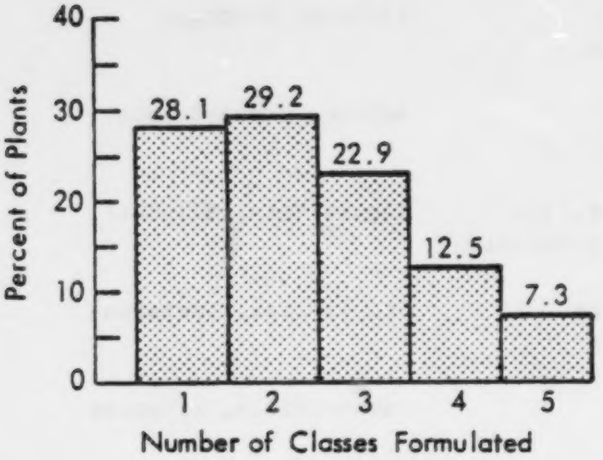


Figure 5. Distribution of plants by number of active ingredients produced at each plant.

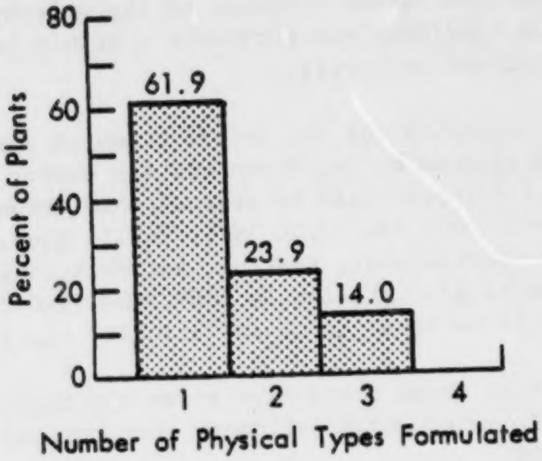
Table 5. PESTICIDE MANUFACTURERS PRODUCING A LARGE NUMBER OF ACTIVE INGREDIENTS AT A SINGLE LOCATION

Company	Location	No. of active ingredients produced
Dow Chemical Company Agricultural Division	Midland, Michigan	28
Rorer-Amchem Company Amchem Products Division	Ambler, Pennsylvania	22
Mobay Chemical Corporation Chemagro Agricultural Division	Kansas City, Missouri	21
Ciba-Geigy Corporation Agricultural Division	St. Gabriel, Louisiana	16
Transvaal, Inc.	Jacksonville, Arkansas	16
Blue Spruce Company	Edison, New Jersey	13



Classes: Organophosphate, inorganic, chlorinated hydrocarbon, nitrogen based, and all others

Figure 6. Distribution of large formulation plants by the number of chemical classes of pesticide active ingredients formulated.



Types: Liquids, powders and dusts, granules, and all others (strips, baits, etc)

Figure 7. Distribution of large formulation plants by number of physical types of formulations.

PESTICIDE DEVELOPMENT COSTS

The cost of introducing a new pesticide into the market has increased from approximately $2 million in 1960 to $8 million in 1976.[9,11] These figures include research and development, testing, manufacturing and formulating, capital investment, registration requirements, and marketing costs. A candidate pesticide that fails midway in the process can represent a significant loss in investment and future revenues to the unlucky company. On the other hand, a successful candidate can represent a highly lucrative product, particularly if it has unique properties.

The previous cost estimates for the introduction of a new pesticide over the last 16 years are distorted by inflation and are better interpreted in terms of constant (1967) dollars. This is accomplished through the use of a deflator or price index: 1960, 88.7; and 1976, 167.5. Thus, the estimated total cost for research, development, testing, and marketing a new pesticide in constant 1967 dollars is $2.2 million in 1960, and $5.0 million in 1976. This amounts to a two-fold increase in noninflationary costs over 16 years.

There is no doubt that total costs have risen and that inflationary pressures are only partly to blame. Noninflationary cost increases include at least the following items:

* An increasing number of chemicals must be synthesized and investigated for desired pesticidal activity before a successful candidate is found.

* Toxicology, metabolism, efficacy, and environmental testing requirements have become more sophisticated.

* Marketing costs (distribution, promotion, and pricing decisions) have increased due to competitive pressures.

* The time lag between discovery and introduction in the market place has increased, thus requiring a greater expenditure of money, time, and management efforts. It is now estimated that up to 100 months may be required from discovery to final registration.[11]

* The cost of capital for investment has increased significantly in the last 4 years.

A pesticide company may research and test between 3,000 and 6,000 chemicals in order to successfully market one new active ingredient.[9] Table 6 presents estimated costs to research, develop, test, register, and market a new pesticide in 1976.

Table 6. PESTICIDE DEVELOPMENT COSTS - 1976[9]

Activity	Cost (million $) 1976	Cost (million $) 1967 = 100
Research and development Synthesis and screening Field testing and development Formulation and process development	2.5 - 5.0	1.5 - 3.0
Testing and registration Toxicology, metabolism, and label requirements	0.5 - 0.7	0.3 - 0.42
Manufacturing capital investment	3.0 - 4.0	1.8 - 2.4
Formulating capital investment	0.0 - 0.4	0.0 - 0.24
Marketing development	0.25 - 0.5	0.15 - 0.30
Total, range	6.3 - 10.6	3.7 - 6.4
Total, average	8.5	5.0

PESTICIDE MARKETING ACTIVITIES FOR THE FRUIT INDUSTRY

The introduction of new pesticides has been rapid, especially since World War II, which indirectly brought about the development of organophosphate esters and chlorinated hydrocarbons of which DDT is the most well-known example. However, beginning about 1970, various factors slowed the growth rate of new pesticides (new active ingredients), and four of these factors were:

1. The tremendous increase in total cost in developing a new pesticide caused by capital equipment cost, inflation, and, to a lesser extent, by the degree of sophistication and depth of information required for registration.

2. Adverse economic factors principally from cash flow problems, capital investment in sophisticated plant and laboratory equipment, and high interest rates, etc.

3. The effect of governmental legislation and regulation of the pesticide industry.

4. A slowing of scientific advancement and innovation in the field of synthetic organic pesticides in the late 1960's and early 1970's.

Previous successes were largely based on pesticide research extending as far back as World War II. In effect, pesticide research, in about 1970, had reached a technological plateau. The "first generation" pesticides (chlorinated hydrocarbons attacking the central nervous system) and the "second generation" pesticides (organophosphates and carbamates inhibiting cholinesterase) resulted in the development of many pesticides differing basically in the number and kind of substituents attached to a common grouping characterizing a class of pesticides (e.g., substituted nitrogenous compounds or thio- and dithiocarbamates, etc.). These developments led to many related pesticides being developed from 1944 to the late 1960's. A technological plateau was reached in approximately 1968 and lasted to 1972 when the "third generation" pesticides (pheromones or insect communication chemicals and insect and plant growth regulants) were commercially available.

Figure 8 indicates the historical time scale for the development of modern synthetic organic pesticides. Omitted from this categorization of synthetic organic pesticides are the well known bacterial pesticides, *Bacillus thuringiensis* and *B. popillae*, and the first viral pesticide, Elcar®, based on *Heliothis Zea*, a nuclear-polyhedrosis virus, registered in 1976.

As an example of the recent decline in marketing activity of pesticides, Figure 9 presents the number of "new" pesticides available to the fruit grower from 1968 to 1976.[12/] The graph indicates total marketing activity for pesticides as the sum of new (active ingredient) pesticides, new formulations of old pesticides, and old formulations extended to new crops and pests. The products refer to pesticide applications for fruit and ornamental trees, berries, nuts, flowers, and vegetables. Beginning in 1968, the total marketing activity for pesticides of importance to fruit growers rose from 25 products introduced annually to 36 products in 1973. From 1974 to 1976, however, the number of new pesticide products for fruit growers has been substantially lower, i.e., only 15 to 20 products per year. The actual number of new active ingredients introduced each year from 1970 through 1976 was approximately three, which indicates the development activity centered upon older active ingredients combined into new formulations or extended to other crops and pests.

The previous quantitative discussion applies only to the American fruit growing industry. However, it is believed the trend toward fewer new pesticide active ingredients being introduced annually is qualitatively true for the entire pesticide industry. Figure 10 indicates the number of major pesticides introduced in the United States from 1931 to date. These data are by Dr. Wendell Mullison of Dow Chemical - USA.[13,14/]

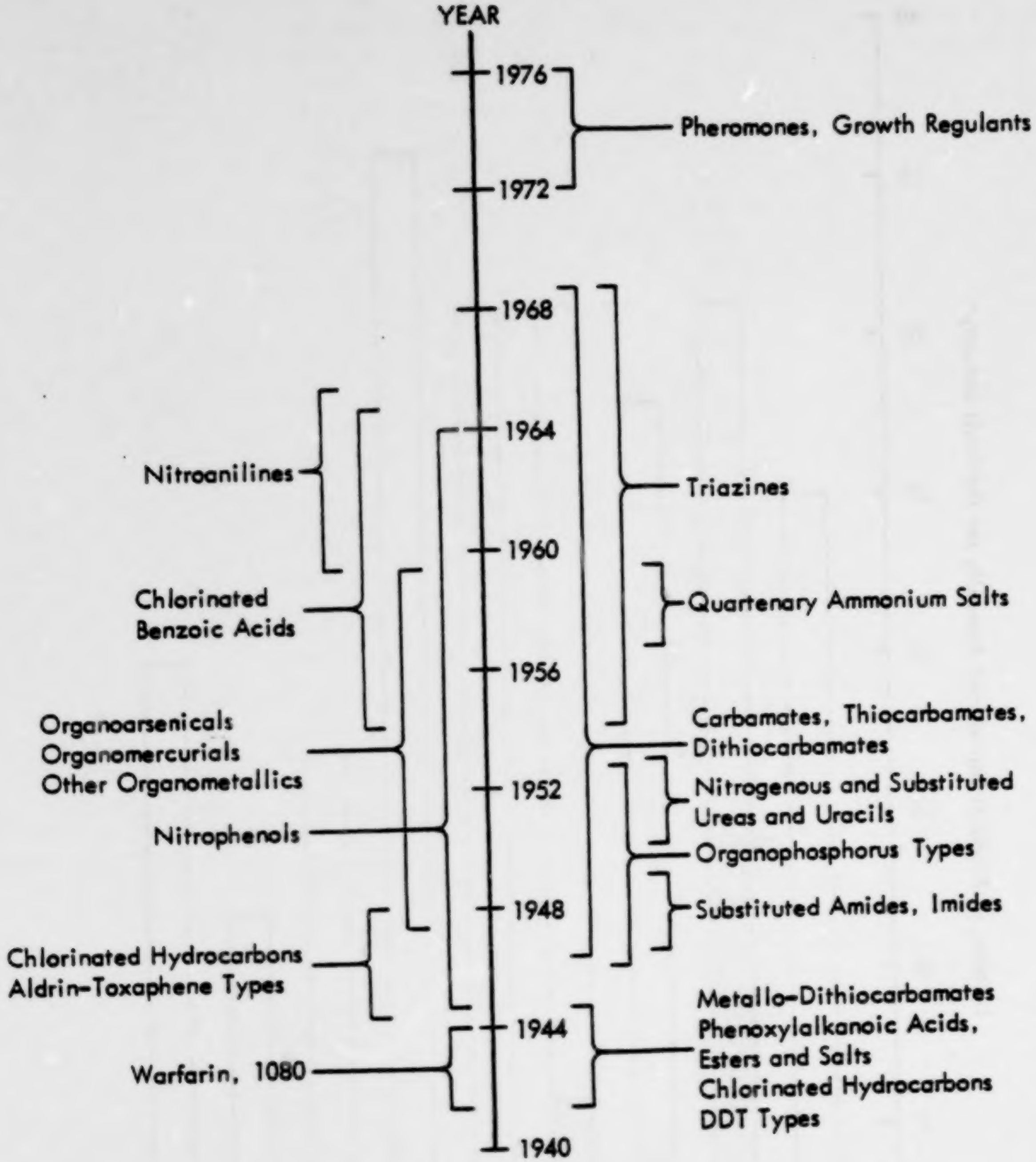

YEAR
1976
1972
1968
1964
1960
1956
1952
1948
1944
1940
Pheromones, Growth Regulants
Triazines
Quartenary Ammonium Salts
Carbamates, Thiocarbamates, Dithiocarbamates
Nitrogenous and Substituted Ureas and Uracils
Organophosphorus Types
Substituted Amides, Imides
Metallo-Dithiocarbamates
Phenoxylalkanoic Acids, Esters and Salts
Chlorinated Hydrocarbons DDT Types
Nitroanilines
Chlorinated Benzoic Acids
Organoarsenicals
Organomercurials
Other Organometallics
Nitrophenols
Chlorinated Hydrocarbons Aldrin-Toxaphene Types
Warfarin, 1080

Figure 8. Historical development of modern synthetic organic pesticides.

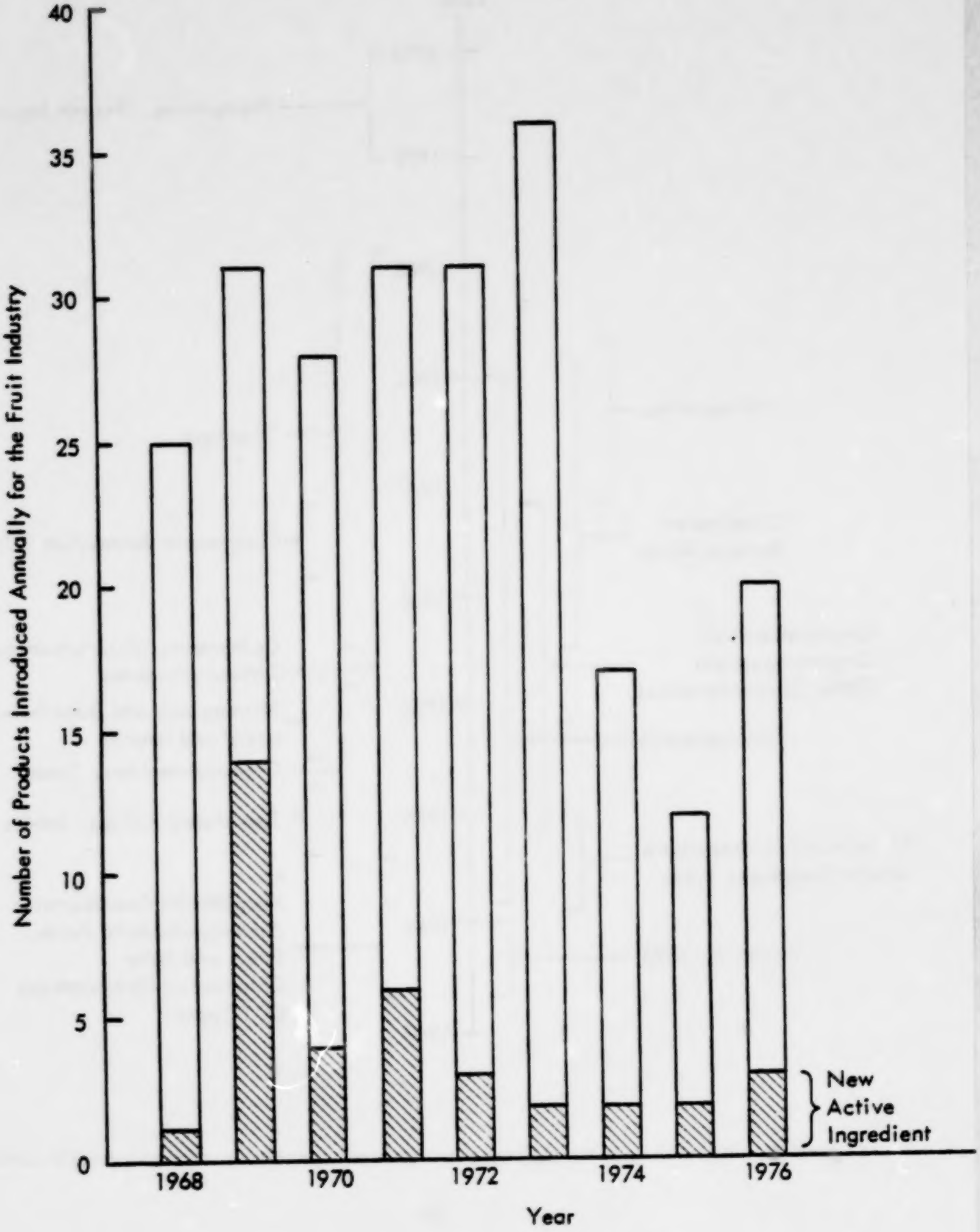


Figure 9. Aggregate marketing activity for pesticides in the fruit industry.

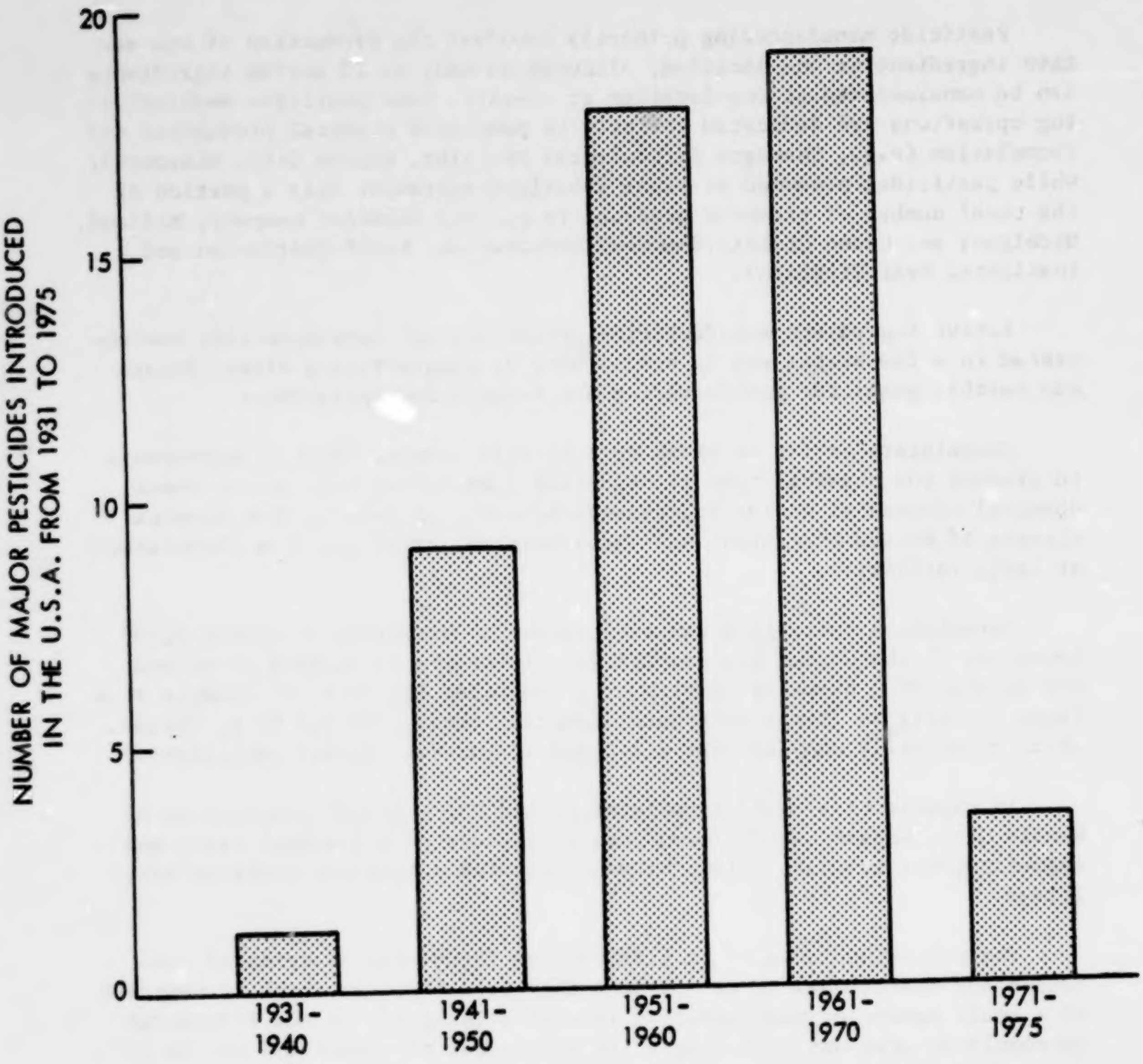


Figure 10. Number of major pesticides introduced from 1931 through 1975.

Source: Proceedings of the 30th North Central Weed Control Conference, Milwaukee, Wisconsin, December 1975.

CONCLUDING REMARKS CHARACTERIZING THE PESTICIDE INDUSTRY

Pesticide manufacturing primarily involves the production of one active ingredient at one location, although as many as 28 active ingredients can be manufactured at one location at present. Some pesticide manufacturing operations are dedicated strictly to pesticide chemical production and formulation (e.g., Chemagro Agricultural Division, Kansas City, Missouri), while pesticides produced at other locations represent only a portion of the total number of products produced (e.g., Dow Chemical Company, Midland, Michigan; and Union Carbide Chemical Corporation, South Charleston and Institute, West Virginia).

Active ingredient manufacturing operations are geographically concentrated in a few states and 16 states have no manufacturing sites. Alaska has neither pesticide manufacturing nor formulating operations.

Formulators prefer to blend or otherwise combine various ingredients to produce one physical type of pesticide formulation with one to three chemical classes of active ingredient. However, as many as five chemical classes of active ingredient and three physical types could be formulated at large facilities.

Formulation operations are geographically dispersed in nearly 5,700 locations in the United States. The facilities are of varying sizes and may be part of a chemical complex or a dedicated facility. An example of a large facility is Thompson-Hayward Chemical Company, Kansas City, Kansas, which principally manufactures 2,4-D and formulates several pesticides.

An example of a small formulator is the PBI - Gordon Corporation of Kansas City, Kansas, which formulates pesticides on a seasonal basis and augments their business volume by manufacturing automotive radiator antifreeze.

The pesticide industry is difficult to categorize in terms of processes and operations. It is not like the steel industry which is composed of a small number of manufacturers located principally in the Pittsburgh metropolitan area and utilizing a limited number of processes; nor is it like other portions of the chemical industry, e.g., the bromine industry concentrated in Arkansas and Michigan and dominated by six producers and essentially one process; nor is it like the vinyl chloride industry composed of 11 companies located at 15 sites and utilizing four different processes. It is possible to describe the vinyl chloride manufacturing operation in terms of a representative facility having measured and/or estimated emission rates. The chemistry of the emitted pollutants from a vinyl chloride plant is well-known. A threshold limit value (TLV) has been established. The pesticide industry cannot be similarly categorized nor have emissions standards been established for many pesticide active ingredients.

One feasible methodology for assessing the pesticides industry is to take into account the previously described characteristics of the pesticides industry and to examine the pollution potential of various different active ingredients by assessing the manufacturers of those active ingredients. This can be achieved by selecting active ingredients which have a high pollution potential. Section 4 presents the methodology used in this study to select the individual pesticides for future detailed source assessment.

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10. Ferguson, T. L. Pollution Control Technology for Pesticide Formulators and Packagers. EPA-660/2-74-094, January 1975.

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12. American Fruit Grower. (1968 to 1976 inclusive).

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SECTION 3

POLLUTION POTENTIAL IN PESTICIDE MANUFACTURING AND FORMULATION

An EPA document issued in 1972 surveying the potential for pollution arising from pesticide manufacturing operations outlined in detail hazards arising from raw materials, active ingredients, production processes, storage, handling, and shipping.[1] The report also considered the pollution potential arising from by-products, intermediates, wastes, cleanup and decontamination of equipment, and included a discussion of safety practices. Except for updating of production volumes, toxicity data, and including effluent discharge permit information, the general conclusions and recommendations outlined in the report are valid today. Indeed, the continued widespread usage of pesticides, the general increase in production volume of pesticides, and the overall pollution potential dangers as recognized by EPA, state, and local officials reemphasize the validity of the conclusions and recommendations. Appendices B and C contain recent information on pesticide production volumes, toxicity data, and a general updating of the Summary Section contained in the 1972 document.

Briefly, the conclusions contained in the 1972 document can be updated in terms of air, water, and solid emissions from the manufacturing sites as follows:

1. Air emissions are generally not regularly monitored by any agency or organization. A limited amount of air emission data for pesticide facilities is available through some state agencies, e.g., California and Louisiana. Presumably there have been some air surveys taken by the pesticide manufacturers themselves, but any hard data are held in strict confidence. Existing data on air emissions that MRI have uncovered are contained in Appendix D.

2. Water discharges to navigable rivers or their tributaries are regulated through the discharge permit system, National Pollutant Discharge Elimination System (NPDES). Dischargers with NPDES permits are required to file self-monitoring discharge reports with EPA regional offices or approved state agencies on a regular basis using an NPDES Monitoring Discharge Form. The report contains actual discharge data from the manufacturing or formulating facilities and indicates actual quantities of chemicals discharged over a given period of time, e.g., pounds of active ingredient per day. An excellent discussion of the national discharge permit system and information regarding compliance by C. J. Schafer and N. Lailas of EPA is readily available.[2] Copies of NPDES Discharge Monitoring Form for the Ciba-Geigy Corporation herbicide plant at St. Gabriel, Louisiana, and for the Monsanto Company herbicide plant at Muscatine, Iowa, are reproduced in Appendix D, Tables D-7 and D-8, respectively. Copies of the applications for permits to discharge and the discharge data are available through EPA.

Sophisticated water treatment systems have been installed by many manufacturers to comply with existing legislation. However, some manufacturers dispose of liquid wastes by evaporation ponds, deep well injection, discharge to municipal sewers or transportation to off-premises disposal sites (e.g., approved landfills, disposal service companies, etc.). Wastewater discharges could represent a significant pollution potential, but data in these areas are sparse. Water discharge data compiled by MRI are contained in Appendix D.

3. Solid waste disposal continues to be an unknown factor. Oftentimes solid waste is disposed by landfill operations on the manufacturing or formulating site and is not monitored nor regulated. Alternately, contract waste collectors will remove the solid waste materials with little or no knowledge of the composition of the wastes being handled. Solid waste discharge data available to MRI are contained in Appendix D.

THE PESTICIDE FACILITY AS AN INPUT-OUTPUT SYSTEM

A manufacturing or a formulation plant may be viewed as an input-output system and emission and control points readily identified. Figure 11 presents such an overview and indicates emission points, control device points, various discharge routes, and intermedia transfer points.

In a general sense, air emissions from the pesticides industry are analogous to emissions from conventional chemical manufacture. Emissions, including particulates and gases from the manufacturing process, emanate from various pieces of equipment and enter the atmosphere as raw materials, intermediates, by-products, and the active ingredient itself. Several air emission control devices are available such as baghouses, filters, carbon sorption units, cyclone separators, electrostatic precipitators, gas scrubbing units, and incinerators for purposes of trapping, separating, washing and otherwise collecting or combusting gases and particulates.

Two facts regarding control devices for air emissions from the pesticide industry must be noted: (a) except for incinerators, these devices transfer the highly toxic materials from the gases and particulates in the "gas" phase to the solid or liquid phase; and (b) unless the air emissions are chemically transformed or destroyed by the control device, the hazardous materials remain unchanged. The net result is that the hazardous air emissions are concentrated into a presumably more convenient form for recycling back through the process, further treatment, or decontamination if necessary.

Liquid or solution discharges of hazardous materials can include all of the previous types of raw materials, intermediates, by-products, active ingredient, etc., plus those discharges from the air emission control devices which

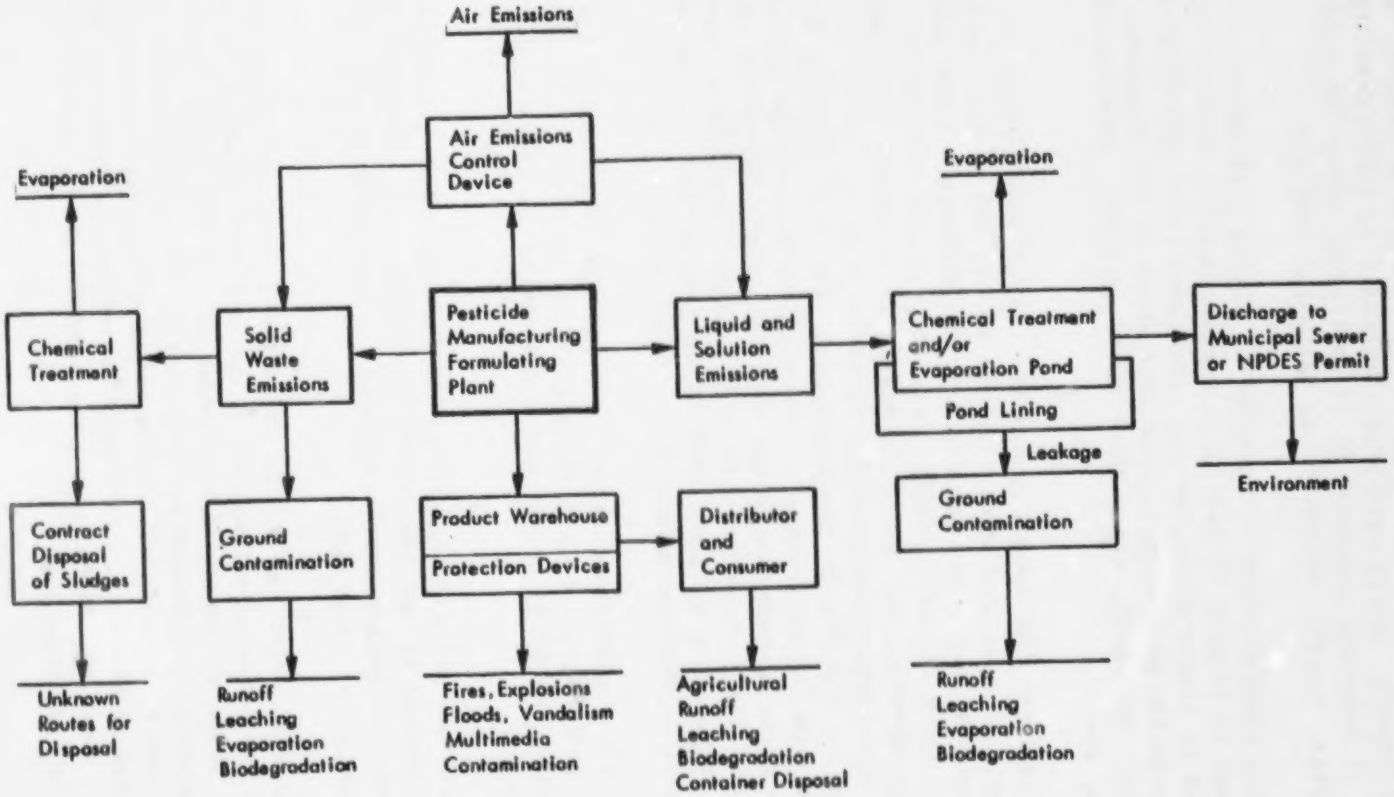

Air Emissions
Air Emissions Control Device
Evaporation
Chemical Treatment
Solid Waste Emissions
Pesticide Manufacturing Formulating Plant
Liquid and Solution Emissions
Evaporation
Chemical Treatment and/or Evaporation Pond
Pond Lining
Leakage
Discharge to Municipal Sewer or NPDES Permit
Environment
Contract Disposal of Sludges
Ground Contamination
Product Warehouse
Protection Devices
Distributor and Consumer
Ground Contamination
Unknown Routes for Disposal
Runoff
Leaching
Evaporation
Biodegradation
Fires, Explosions
Floods, Vandalism
Multimedia
Contamination
Agricultural
Runoff
Leaching
Biodegradation
Container Disposal
Runoff
Leaching
Evaporation
Biodegradation

Figure 11. Schematic representation of pesticide manufacturing and formulation plant emissions

yield liquid concentrates, e.g., solutions from scrubbers. The liquid or solution discharges should receive a chemical treatment depending on the specific nature of hazardous material to be destroyed. Generally this would involve hydrolysis, neutralization, or an oxidation reaction.

Some manufacturing or formulating plants utilize activated sludge waste treatment to dispose of pesticide wastes. Special chemical pretreatment may be required to insure effective and continuous biota performance; otherwise, the biodegradation process may cease altogether if the organisms become poisoned with toxic materials, e.g., chlorinated solvents, chlorinated phenols, bisphenols, etc.

Oftentimes the liquid wastes go to a holding pond or lagoon after chemical treatment. In some instances this may be the end of the treatment process for liquid wastes; e.g., the manufacturers or formulators may simply allow evaporation to occur and periodically recover a sludge from the pond or lagoon by dredging. However, pollution potentials exist during the evaporation or holding period. For example, evaporation of undestroyed hazardous material could occur, resulting in transfer to the atmosphere, and thus negating the previous benefits obtained from the air emissions control device. Leakage through unlined ponds can also occur whereby hazardous material enters the ground at the plant site and establishes a potential leaching or runoff problem or a potential groundwater contamination problem. Some holding ponds may also be subject to overflow from runoff of surface waters during heavy rains.

If, after chemical treatment and partial evaporation, the manufacturer or formulator discharges to a navigable stream or river, then the effluent is regulated by the NPDES permit and the operator is responsible for his actions at that point.

Liquid and solution discharges may escape detection by regulatory or monitoring agencies if the wastes are discharged to a municipal sewer system. Only if the discharges are to navigable waters do they come under the jurisdiction of the Clean Water Act.

Solid discharges and solids collected by the air emission control devices leave the pesticide plant and may or may not have chemical treatment prior to disposal. These alternatives are chosen at the discretion of the operators. Oftentimes solid discharges as by-products, off-specification active ingredient that cannot be reworked, contaminated nonrecoverable materials, empty and contaminated drums, etc., are simply buried on the property. This practice can create potential leaching and runoff problems in addition to re-evaporation of semivolatile materials.

Contract disposal of solid and liquid wastes is a prevalent and a growing business. Contractors are regulated to some degree, but often they have little information on the composition of the waste mixtures and may not be able to determine if the wastes have been rendered harmless.

Finally, the product as active ingredient or formulated material is packaged and enters the warehouse for temporary storage. A pollution potential exists in the form of fires, explosions, floods, vandalism, neglect, etc. If the contents of warehouses are not protected against any of the above potential dangers, then gross environmental insult could occur. Sprinkler systems, smoke and heat detectors, electrical grounding, dikes around the warehouse, fences, security patrols, etc., are all recommended methods for reducing the danger of pollution.

The various types of emissions from manufacturing and formulating operations include but are not limited to the following:

Emission Type	Waste Materials
Air	Evaporation losses as methanol, hydrocarbon solvents, and from intermediates, by-products, active ingredient (AI), and organic sludges.
Liquid	Methanol, hydrocarbon solvents, intermediates, by-products, AI, aqueous and solvent losses from cleaning and rinsing operations of cans, drums, and process equipment.
Solid	Intermediates, by-products, AI, $NaCl$, $NaCN$, Na_2SO_4, $(NH_4)_2SO_4$, HNO_3, HCl, chlorinated phenols, bis-phenols, contaminated cans, drums, bags, etc.

Control technology (procedures, devices, apparatus, etc.) is presently available to alleviate, transform, capture, and otherwise control and/or contain pesticide emissions. Excellent discussions of procedures and control devices appropriate to the pesticide manufacturing and formulating industry are available.[3-5]

Examples of gross contamination of the environment with resultant risk to all forms of life from pesticide plants are readily available. During the short period of this contract, January through April 1976, the following incidents became publicly known:

1. Full disclosure of the events leading up to the Kepone® incident by Allied Chemical and Life Science Products Company of Hopewell, Virginia, wherein plant workers allegedly became seriously ill from the manufacture of Kepone® and the subsequent illegal discharges of tonnage quantities of off-specification active ingredient into the James River.[6]

2. A pesticide warehouse fire at FMC Corporation of Ennis, Texas, caused 600 persons to be evacuated from their homes when potentially poisonous fumes threatened the community. The force of the explosion hurled 55-gal. drums hundreds of feet into the air.[7]

3. Gaseous emissions as foul-smelling odors from Central International Chemical Corporation of Liberty, Texas, caused citizen complaints and resulted in a continuous monitoring program to be set up by the Texas Air Control Board.[8]

The three cases of pollution and environmental contamination previously described represent a wide range of pesticide emission problems. The emissions from the Kepone® plant consisted of aqueous and solvent wastes heavily laden with active ingredient which were ineffectively treated prior to release into the James River. Further, large quantities of off-specification technical material were apparently disposed of as solid material rather than re-worked or blended with acceptable batches of active ingredient. Inadequacies in control technology are presumably not at fault in this case.

The pesticide warehouse fire represents a catastrophic situation which resulted in active ingredient, formulated products, thermally degraded substances, noxious gases, particulates, etc., being suddenly released into a community in the form of gases, vapors, particulates, and other debris. While such events are rare and protection devices are available to protect the contents of the warehouse, situations such as these do occur and represent a very real danger to workers, the community, and the environment.

The last case involved gases and/or particulates released from a pesticide facility formulating Imidan®. This phosphorodithioate has a particularly offensive odor and is easily detected by the olfactory nerves. Imidan® may be formulated as a 20 to 30%, by weight, emulsifiable concentrate or as a 50% wettable powder.

Ambient air samples taken downwind from the facility and near the plant property line indicated 0.5 to 1.5 mg/m^3 of Imidan®. The Central International Chemical Corporation has subsequently installed carbon filters in the hoods and ventilating systems to alleviate this nuisance problem.

As stated earlier, manufacturers and formulators must monitor various plant emissions and report these data as required by the NPDES permit and/or various state regulatory agencies. They may also monitor the general chemical operations for their own source of information to determine if the processes are in control. This would be done by performing material balance calculations on an input/output basis and would be a matter of good economics and business sense.

Manufacturers and formulators would prefer to operate with a near 100% material balance, but as a matter of practicality a small and variable uncertainty, e.g., 2 to 3%, in the material balance study is permitted. The uncertainty is often related to analytical statistical variation; e.g., an industrial analytical method is rarely better than ± 1% and in most cases is between 1 to 2%. Variations in process conditions and operation of equipment can also introduce uncertainties in the material balance of 1 to 2%. In general, however, losses of any kind--raw materials, intermediates, and active ingredient (AI)--represent dollar losses and will be controlled and/or eliminated to some extent through competitive pressures.

Certain manufacturing and formulating operations such as combining (mixing or blending) raw materials and/or intermediates can be made highly efficient, near 99%, with only ~ 1% physical handling loss. However, if a grinding operation is encountered leading to fine particle and/or dust generation, a 96 to 97% recovery may exist. The losses amounting to 3 to 4% are due to escape of fine particles and moisture. Such losses are difficult to reduce because of the very nature of the material and/or the process.

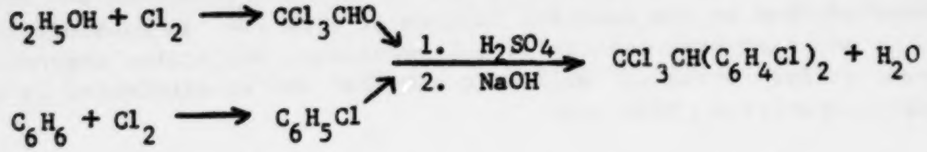
As two examples of viewing the pesticide manufacturing or formulating facility as an input/output system we shall examine the Montrose DDT plant at Torrance, California, and the Ciba-Geigy herbicide plant at St. Gabriel, Louisiana. These examples were chosen because the emissions data are reasonably complete in contrast to emissions data for other facilities and active ingredients thus far uncovered. The authors of this report do not intend to single out these facilities and active ingredients as being representative of the pesticide manufacturing industry. Undoubtedly other cases could be examined in a similar manner if only the appropriate data were available.

DDT Manufacture[9]

DDT is currently manufactured at only one plant in the United States, the Montrose Chemical Corporation facility at Torrance, California. The plant also prepares DDT formulations. The current production capacity is about 85 million pounds of DDT per year. The 1975 production rate for DDT at this plant is reported to be about two-thirds of capacity. The rate of production is essentially constant during the year. Montrose produces technical grade DDT for sale to WHO, AID, and directly to foreign nations in the Northern and Southern Hemispheres.

DDT (dichloro-diphenyl-trichloroethane) is a name that covers a few isomers, the most active of which is 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane. Its manufacture is relatively simple: it is made by condensing monochlorobenzene and chloral in the presence of concentrated sulfuric acid.

Production Chemistry



$$C_2H_5OH + Cl_2 \longrightarrow CCl_3CHO \qquad C_6H_6 + Cl_2 \longrightarrow C_6H_5Cl$$

$$CCl_3CHO + C_6H_5Cl \xrightarrow[2.\ NaOH]{1.\ H_2SO_4} CCl_3CH(C_6H_4Cl)_2 + H_2O$$

75-80%, p,p'-isomer
15-20%, o,p'-isomer
plus related compounds
including DDD and DDE*

The biggest problems in DDT manufacture are in the recovery of unreacted ingredients and in steering the reaction toward production of the desired isomer. The reaction is kept below 30°C and takes place at atmospheric pressure in a stirred batch reactor system.

DDT recovery is by crystallization. Impure DDT is washed with a caustic solution. The washed DDT is then dried and crystallized into solid material. A production and waste schematic for DDT is presented in Figure 12. The manufacturing process is continuous except for batch input to the first stage of the reactor. The plant operates on a three shift per day, 7 days a week basis, except for routine maintenance and lost time caused by breakdown in operating equipment. The on-stream time each calendar year is reported to be 360 days.

Data for the Montrose DDT operations at Torrance, California, for production equipment, raw materials, by-products, and other process wastes and losses are listed below.

Production Equipment

Process continuity: semibatch
Equipment dedication: DDT only
Equipment age: Not available

Est. annual production: 60 MM lb/year (1975)
Plant capacity: 85 MM lb/year
Formulation on site: Yes

Raw Materials

Material	Received from	Received by	Storage
1. Chloral	Henderson, Nevada	Tank cars	Steel storage tanks on plant site
2. C_6H_5Cl	Henderson, Nevada	Tank cars	Steel storage tanks on plant site

---

* DDD is 2,2-bis(p-chlorophenyl)-1,1-dichloroethane; DDE is dichlorodiphenyldichloroethylene.

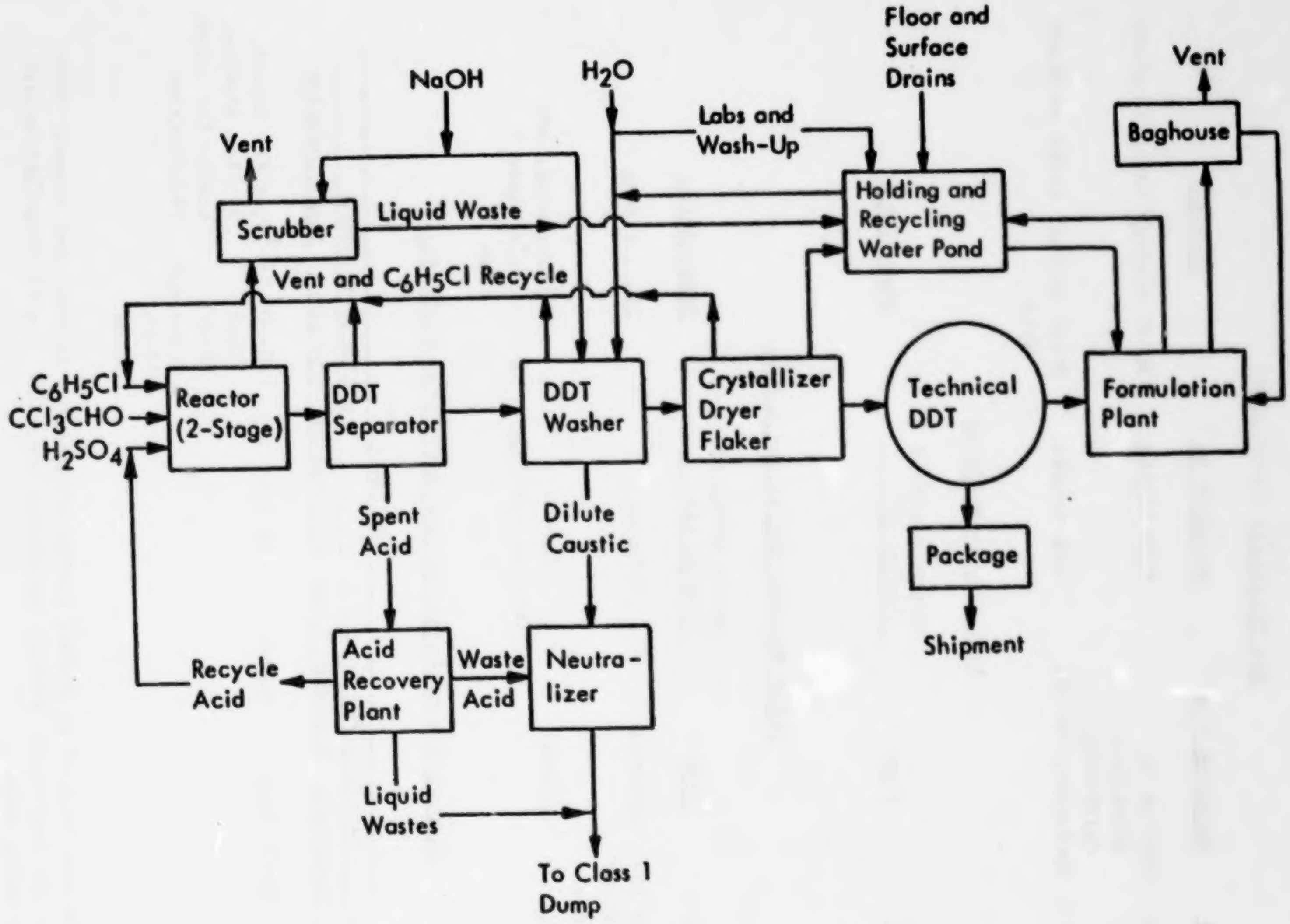

Floor and Surface Drains
Vent
NaOH
H_2O
Labs and Wash-Up
Baghouse
Vent
Holding and Recycling Water Pond
Scrubber
Liquid Waste
Vent and C_6H_5Cl Recycle
C_6H_5Cl
CCl_3CHO
H_2SO_4
Reactor (2-Stage)
DDT Separator
DDT Washer
Crystallizer Dryer Flaker
Technical DDT
Formulation Plant
Spent Acid
Dilute Caustic
Package
Shipment
Acid Recovery Plant
Waste Acid
Neutra-lizer
Recycle Acid
Liquid Wastes
To Class 1 Dump

Figure 12 - Production and waste schematic for DDT

Raw Materials (Concluded)

Material	Received from	Received by	Storage
3. Oleum	Compton or Dominques, California	Tank trucks	Steel storage tanks on plant site
4. Caustic	Henderson, Nevada	Tank trucks	Steel storage tanks on plant site

Reaction By-Products

Material	Form	Amount produced (lb/lb AI)	Disposition
1. None			

Other Process Wastes and Losses

Material	Form	Amount produced (lb/lb AI)	Disposition
1. Active ingredient	Aqueous	Unknown	Class 1 dump
2. Solvents			
3. Na_2SO_4	Aqueous	0.87 10-15 cu yard/day	Holding pond, recycle Class 1 dump

Disposition of Technical and Formulated Products

	Shipments				
	Technical product		Formulated products		
Warehouse on site	Container	Transportation	Formulation	Container	Transportation
X	50-lb bags	Boxcar	WP (75% AI)	100-200 lb lined fiber drums and 75-lb boxes	Truck for export via Los Angeles; boxcar for other destinations

Hoods are located at points having emissions potential and exhaust under vacuum to six baghouses. Venturi scrubbers are used. Liquid formulations are no longer being made.

Montrose maintains its own quality control laboratory for routine analyses. Setting point is the major quality control used. To date they have had no off-specification material that could not be reworked.

General Wastewater Characteristics--

The wastes resulting from the DDT manufacturing process include spent acids (hydrochloric and sulfuric), sodium monochlorobenzene sulfonate, chloral, NaOH caustic wastewaters, monochlorobenzene, and sulphonic acid derivatives. The waste streams may contain DDT in the 1 to 5 mg/liter range with DDE and other related compounds present in amounts up to four times the DDT level. The pH of the waste is low and the salt content is high.

The volume of spent acid reported for DDT manufacture ranges from 440 to 550 gal/ton of DDT. This liquid contains 55% acid and 5% other organic substances and water. The first washwater, about 800 gal/ton of DDT made, contains from 2 to 6% spent acid. The second washwater, also about 800 gal/ton of DDT made, contains a very small proportion of spent acid neutralized with sodium carbonate.

Wastewaters also result from the absorption of the mixed gases from the manufacture of chloral alcoholate. The gases are first water washed, producing a 10% by weight solution of hydrochloric acid (2,700 to 2,900 gal/ton of DDT). The gases are then washed with a caustic soda solution, producing a solution (220 to 440 gal/ton of DDT) containing sodium hypochlorite equivalent to 2.0% chlorine, sodium chlorate equivalent to 0.2 to 0.5% chlorine, some sodium chloride and excess sodium hydroxide.

Wastewater Characteristics - Montrose Chemical Corporation--

The process portion of the DDT plant has no liquid waste outfall. Wastewater flow is contained within the plant by a closed-loop processing system, and use of a sealed bottom holding-recycling pond, except for about 30,000 gal/day of alkaline wastewater and about 10,000 gal/day of acid waste, which are currently removed by truck and placed in a California-approved Class 1 dump.

There is some decomposition of DDT in the process reactor, and HCl and SO_2 are present in the vent gas. The vent from the reactor is scrubbed with caustic and water. Liquid from off-gas vent scrubbers and surface drainage from the DDT plant area is collected in a holding pond and recycled to the process. This pond serves as the surge capacity for the cooling water system and there is essentially no evaporation of water from this pond.

The holding pond (approximately 75 ft x 50 ft x 15 ft deep) has been used for about 20 years, but was lined with concrete about 5 years ago to overcome the necessity of installing test wells to monitor possible leaching. Montrose indicates that this recycle system has been satisfactory and that no significant changes would be made if it had to be constructed today.

At present, the segregated alkaline wastewater from the Montrose DDT plant averages about 30,000 gal/day, but it is estimated that the discharge rate could range up to about 45,000 gal/day if the plant were operated at the maximum DDT capacity of about 85 million pounds per year.

Currently, there is one combined source of about 5,000 gal/day of wastewater which is being discharged into the sewer of the Torrance, California, plant for DDT production. The breakdown and analysis of this waste stream for DDT and metabolites (DDD and DDE) are as follows:

Source	Gal/day	DDT + DDD + DDE (ppm)	Lb of DDT/day
Engine room	2,500	0-0.005	0-0.0001
Sanitary waste	2,500	0-0.005	0-0.0001
	5,000	0-0.010	0-0.0002

Sources of the principal waste, alkaline wastewater, are neutralized caustic liquor from the DDT-washing operation, tar pot drainings, spills and tank drainings. In 1975, this effluent discharge rate was 30,000 gal/day and all of this wastewater was disposed of in a Type 1 landfill. A typical analysis for 1975 of the alkaline wastewater, based on a flow rate of 30,000 gal/day and pound per day data, is given below.

Component	Lb/day	Concentration (ppm)
Sodium sulfate	21,615	76,883
Sodium salt of monochlorobenzenesulfonic acid	3,670	13,054
Caustic	50	117.8
DDT (+ DDE, DDD)	119	423.3
Miscellaneous (tars, etc.)	139	494.4
Water	255,550	
	281,143	

The discharge rate and characteristics of this waste are fairly constant and do not show seasonal fluctuations. The DDT plant is on stream at this level of two shifts per week and 12 months/year, except for breakdown and routine maintenance.

In-Plant Control - Montrose Chemical Corporation--

All drains and process sewers at the Montrose plant have been isolated from the city sewer system. Only sanitary waste and boiler blowdown water go to the city sewers. The restroom lavatory basins, however, discharge to the holding pond system. Water consumption has been reduced from about 20 million gallons to about 2 million gallons per month. Water from the holding pond is also used for cooling water without filtration. This practice has caused no problem to date. The "recycle" water typically contains 10 to 15 ppm DDT.

Some 10 to 15 cu yards/day of solid waste, bags, empty containers, etc., are also taken by a commercial disposal service to a Class 1 dump, which is approved for wastes of this type in California. Incineration is not approved.

Equipment washdown is not a problem as this is normally done only during shutdowns. Washwater goes to the recycle pond. Spills and leakers have not been a major problem. One spill occurred when a truck carrying technical material had an accident and spilled DDT. The material was picked up along with the top 3 in. of soil and disposed of.

According to the company, DDT losses to the sewer were < 1 lb/day for at least 2 years before modification of the waste treatment facilities and never more than 10 to 15 lb/day since the 1940's. The amounts of DDT entering and leaving various Los Angeles city and county sewers from all sources are uncertain, but DDT is apparently adsorbed strongly on sewage sediments: the county sanitation district removed 0.5 million pounds of sediments said to contain 4,500 lb of DDT. This sediment apparently went also to a Class 1 dump.

Two additional pieces of information concerning water and air emissions from the Montrose DDT plant were obtained from the County Sanitation Districts of Los Angeles County and California Air Resources Board and are quoted below.

Water emissions have been described as follows:

> "In 1970, during the course of a trunk sewer survey aimed at locating sources of pesticide, a net input to the sewer system of 640 lbs/day of DDT was discovered in the vicinity of the Montrose Chemical Corporation, a DDT manufacturer. Through additional testing it was determined that approximately 600 lbs/day of this input was contained in the Chemical plant's discharge, and that the remainder was contributed by DDT-laden sediments previously deposited in the sewer.
>
> "Shortly after this discovery, the Montrose Chemical Corporation discontinued the discharge of its caustic liquor waste, which contained the major portion of the DDT discharge, and within 14 months eliminated all but sanitary and boiler blow-down wastes. During this period, the Sanitation Districts performed extensive

sewer cleaning operations downstream of the Montrose discharge and successfully removed more than 280 tons of sewer sediment.

"By 1972, the input of DDT to the Sanitation Districts system had been reduced to approximately 8 lbs/day, and during 1975 averaged approximately 6 lbs/day. With the current system flow, this amount represents less than 2 ppb influent to the Districts' Joint Water Pollution Control Plant."[10]

Air emissions have been characterized as follows:

"Montrose Chemical Company, the only manufacturer of DDT in Los Angeles County, has been and is presently operating in compliance with all applicable Rules and Regulations of the District. The company has recently undertaken a program to reduce even small losses of DDT and has recently upgraded their air pollution scrubber system which controls emissions from the reactors for manufacturing DDT. The gaseous effluent from three former Venturi scrubbers operating in parallel will pass through two caustic Venturi scrubbers connected in series. Although the company is controlling DDT dust from the operations of DDT grinding, screening, air milling, conveying and bagging, it is adding a sixth baghouse to control dust from two hoppers and two bagging machines.

"DDT losses to the atmosphere from the series of Venturi scrubbers is computed as 0.0008 lb/hr. DDT loss from each of the five baghouses is estimated at a maximum of 0.5 lb/hr. The total DDT loss to the atmosphere is about 2.5 lbs/hr from the plant.

"Diffusion calculations using the Bonsanquet-Pearson equation show a maximum ground level concentration from a single baghouse of 100,000 nanograms DDT per cubic meter. This maximum ground level concentration occurs at a distance of 10 times the stack height and may occur inside or outside the plant depending upon the direction of the wind. The maximum ground concentration from the air pollution Venturi scrubber system is only 1,390 nanograms per cubic meter.

"Obviously, these concentrations are well below the 1,000,000 nanograms per cubic meter (1 mg/cu. meter) for DDT adopted by ACGIH in 1970 and the present OSHA standard shown in the Federal Register.

"We have investigated seven complaints against the company over the past five years and have found that the complaints had nothing to do with DDT dust but were the result of maintenance problems in which oleum (SO_3), ammonia, and monochlorobenzene escaped from vessels.

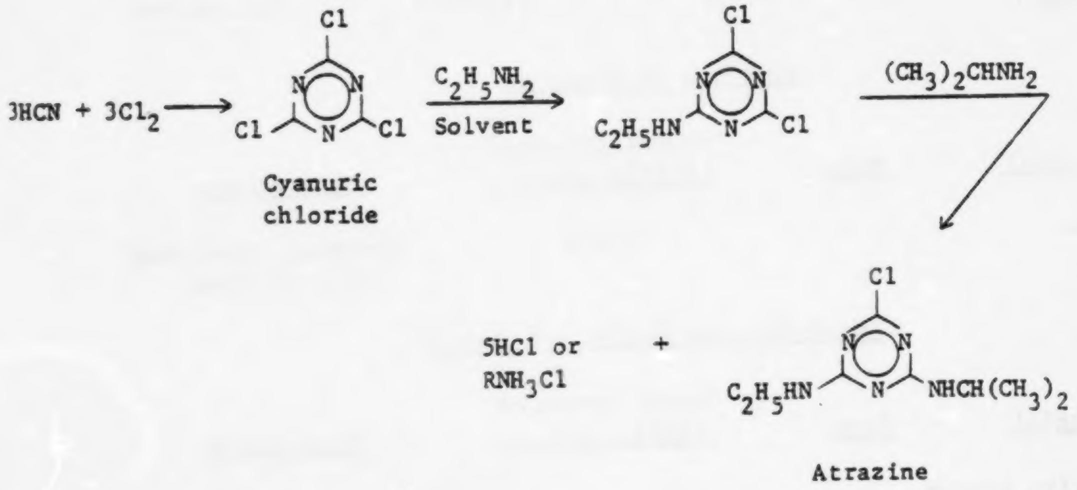
"DDT dust particles which pass through the baghouse fabric or through the Venturi scrubbers are expected to be in the micron or submicron size range. These small particles remain suspended in the air and can travel considerable distances from the plant. Because of the complexity and mathematical treatment of meteorological data, we cannot relate DDT fallout measurements (nanograms per square meter) cited in your letter to the calculated maximum DDT concentrations (nanograms per cubic meter) present in the atmosphere surrounding the plant."[11]

Atrazine Manufacture

Atrazine herbicide is currently manufactured by Ciba-Geigy Corporation at McIntosh, Alabama, and St. Gabriel, Louisiana. Estimated total production of atrazine is 110 million pounds annually.

Atrazine (2-chloro-4-ethylamino-6-iso-propylamino-s-triazine) is made by combining cyanuric chloride with ethylamine and isopropylamine in a continuous process.

Production Chemistry



The product is a solid, nearly insoluble in water, nonpersistent, and of relatively low toxicity (oral LD_{50} 1,750 mg/kg for rats).

A production and waste schematic for atrazine is presented in Figure 13. Other details of the process and the facilities at St. Gabriel, Louisiana, are given below.[1] In comparison to the previous DDT discussion (which benefited from two visits to Montrose Chemical Corporation by MRI staff for previous contracts) much less specific information is known of the atrazine facilities at St. Gabriel.

Production Equipment

Process continuity: Continuous
Equipment dedication: Mostly atrazine, some other triazines
Equipment age: 1970
Est. annual production: 110 MM lb/year
Plant capacity: > 150 MM lb/year
Formulation on site: Yes

Raw Materials

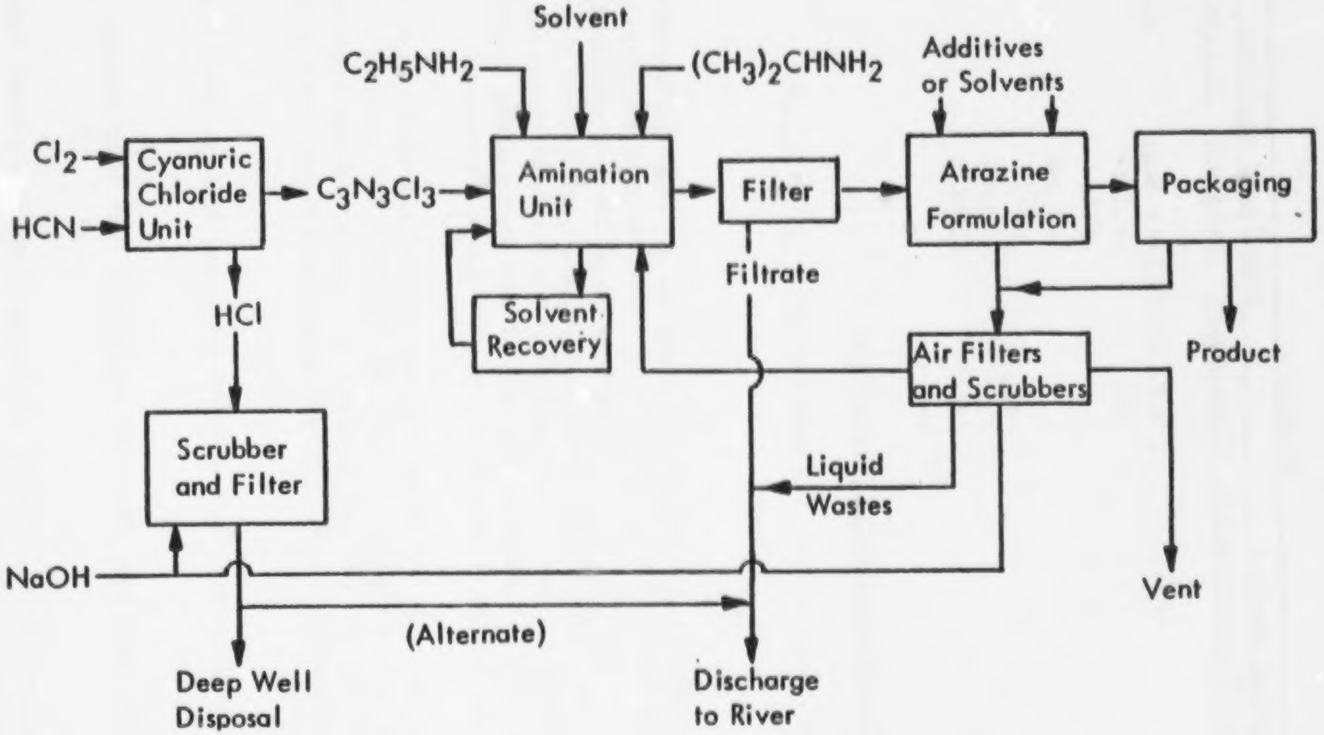
	Material	Received from	Received by	Storage
1.	HCN	Memphis, Tennessee	Tank cars	Tank
2.	"Appropriate" amines	Taft, Louisiana	Tank cars	Tank
3.	Cl_2	Adjacent plant	Pipeline	Not stored
4.	NaOH			

Reaction By-Products

	Material	Form	Amount produced (lb/lb AI)	Disposition
1.	HCl		0.333	Scrubber, then deep well or river

Other Process Wastes and Losses

	Material	Form	Amount produced (lb/lb AI)	Disposition
1.	Active ingredient			
2.	Solvents			
3.	Solid waste			Landfill
4.	Liquid			River



Cl_2
HCN
Cyanuric Chloride Unit
$C_3N_3Cl_3$
HCl
Scrubber and Filter
NaOH
Deep Well Disposal
(Alternate)
$C_2H_5NH_2$
Solvent
$(CH_3)_2CHNH_2$
Amination Unit
Solvent Recovery
Filter
Filtrate
Discharge to River
Additives or Solvents
Atrazine Formulation
Packaging
Product
Air Filters and Scrubbers
Liquid Wastes
Vent

Figure 13 - Production and Waste Schematic for Atrazine

Disposition of Technical and Formulated Products

Warehouse		Shipments				
		Technical product		Formulated products		
On-site	Elsewhere	Container	Transportation	Formulation	Container	Transportation
None	Public warehouseing		Rail	% W.P. (80% AI)	5-lb bags (multi-walled (10 per case)	Rail
				Liquid (4 lb/gal.)	1.5 gal. plastic	

Pollution Control Regulation

1899 Refuse Disposal Act applies to this manufacture X Yes ___ No

Pollution Control

About 1 lb of effluent is generated per pound of atrazine produced--mostly NaCl. Liquid wastes from the cyanuric chloride production unit ordinarily go to a 6,000 ft deep well disposal, after receiving a preliminary polishing (pH adjustment and filtration). The larger amount of liquid wastes from the remainder of the plant are discharged to the river. Sanitary wastes from the plant are chlorinated before they are discharged. The BOD of the waste going to the river is near 500 lb/day at the 110 million pound per year production rate.

Solid wastes are primarily bag wrappers, car lining material, etc. This waste is disposed of by a commercial operator by landfill not located on the plant site. The formulation and packaging areas are controlled by baghouses and wet scrubbers and atmospheric monitors are used. Losses are said to be substantially less than 1%.

Breakage and leakers have not been a major problem. Returns have been < 1%. Overall repackaging is < 2%.

Package disposal is a problem. They can be burned, but what happens to the atrazine is not known.

Air emissions data for the St. Gabriel atrazine plant have been reported by Ciba-Geigy to the Louisiana Air Control Commission as required by state regulation. These data are available to the public but only upon personal visit to the New Orleans office.[12] Due to time and budgetary restrictions it was not possible for the MRI team to obtain these data. (MRI became aware of these data on June 16, 1976.)

Aqueous and other liquid discharge information on the atrazine plant was made available through the NPDES permit and Discharge Monitoring Report from the EPA Region VI Office in Dallas.[13] The pertinent data for March 1976 are as follows:

Atrazine, pound per day:	Reported	469 minimum
		828 average
		1,559 maximum
	Permit Condition	N/A minimum
		1,300 average
		1,950 maximum

The above reported data are for a daily, 24 hr composite sample. Other chemical species reported in the effluent include toluene, carbon tetrachloride, cyanide, and ammonia, and are given in Table D-7 of Appendix D.

In order to gain a perspective of the amount of atrazine disposed daily, some 828 lb/day on the average, it is instructive to recall the average daily production rate is 300,000 lb based on an estimated annual rate of 110 million pounds. Thus, 828 lb/day disposed as liquid wastes represents 0.3% of the daily production of atrazine. However, this represents a large physical quantity of active ingredient which has an estimated intrinsic value of perhaps $1,700 daily.

FACTORS RELEVANT TO THE POLLUTION POTENTIAL IN PESTICIDE MANUFACTURING

The foregoing sections of this report, particularly the overview of the pesticides industry and the input-output approach to pesticide manufacturing and formulating plants, permit a listing of the general factors relevant to assessing the pollution potential of pesticides. Seven general factors and the subfactors for each factor are given in Table 7.

These factors are taken into account in the following two sections. The first section discusses the general methodology required to perform a detailed pollution potential assessment of a pesticide active ingredient. The second section discusses the decision criteria based on quantifiable factors required to evaluate the need for control technology development.

GENERAL METHODOLOGY FOR ASSESSING THE POLLUTION POTENTIAL OF A PESTICIDE PRODUCTION PROCESS

The method employed to assess the pollution potential of a pesticide production process must answer the following questions.

Table 7. GENERAL FACTORS RELEVANT TO THE POLLUTION POTENTIAL OF PESTICIDE ACTIVE INGREDIENTS

Factor	Subfactors
Potential pollutants	Process materials, reactants
	Process materials, nonreactants (catalysts, solvents, etc.)
	Chemical intermediates
	Pesticide active ingredients
	Pesticide degradation products
	Process by-products
Emissions	Unit operations
	Process equipment
	Process techniques
	Housekeeping practices
	Management philosophy
	Control technology
	Disposal techniques
Pollutant identification/ characterization	Toxicological properties
	General toxicity to fish and wildlife
	Acute toxicity: oral LD_{50} - rats
	Subacute toxicity
	Chronic and subchronic toxicity
	Dermal toxicity
	Inhalation toxicity
	Carcinogenicity, mutagenicity, teratogenicity
Source pollutant severity	Production or use volume
	Concentration in air, water, or solids
	Toxicological properties (same as above)
	Carcinogenicity, mutagenicity, teratogenicity
	General health effects
	Synergistic effects
Environmental pollutant severity	Concentration in air, water, or soil
	Behavior in air, water, or soil
	Persistence
	Biodegradability
	Microbial breakdown
	Photodecomposition
	Translocation characteristics
	Volatilization
	Leaching
	Solubility
	Adsorption on soil
	Absorption in soil

Table 7. (concluded)

Factor	Subfactors

Environmental pollutant severity (continued)	Biochemical behavior
	  Mechanism of action
	  Metabolism in plants and animals
	  Persistence in plants and animals
	  Bioaccumulation
	  Biomagnification
	(Also includes all subfactors of source pollutant severity factor)

Population exposed	Human population exposed
	  Geographic location of plant
	  Population distribution
	  Pollutant medium
	    Ambient air
	    Drinking water, water discharge
	    Solid waste dumps
	Wildlife exposure
	  Geographic location of plant
	  Population distribution
	  Pollutant medium
	    Ambient air
	    Drinking water, water discharge
	    Solid waste dumps

Pollution emissions' growth	Future pesticide production
	  Pesticide market changes
	  Government regulations, present and future, for pesticides
	Pollution control technology implementation

- What are the potential pollutants?
- What are the emissions?
- Do the emissions contain pollutants?

These questions can be answered by considering the factors in Table 7.

The first factor, potential pollutants, shows that six subfactors must be considered when identifying the potential pollutants of any pesticide plant. Any of these materials may be emitted into the air, discharged into water, and/or become solid residues during the operation of a pesticide plant. The first step in the assessment methodology is to identify these materials.

The second step in the assessment procedure is to identify and quantify the plant's emissions. The emissions which arise from each unit operation and the process equipment must be identified, sampled, analyzed, and quantified. Other subfactors such as process techniques, housekeeping practice, and management philosophy should be observed, and the effect these variables have upon the type and amounts of emissions should be carefully considered and determined. The control technology and disposal practices used by the plant must be observed and evaluated.

Once the emissions have been qualitatively and quantitatively evaluated, the third step in the procedure is to determine which constituents of the emission streams are pollutants. The third factor, pollutant identification/characterization in Table 7 shows that two important subfactors must be considered when deciding whether a substance is a pollutant or nonpollutant. Each substance must be evaluated using these two subfactors in the manner shown in Figure 14.[14] The toxicological properties and genetic effects of each substance can be obtained from literature sources.

DECISION CRITERIA USED FOR DETERMINING THE NEED FOR POLLUTION CONTROL TECHNOLOGY DEVELOPMENT

After the detailed pollution assessment of the pesticide active ingredient has been performed, a decision must be made as to whether or not development of control technology is required to reduce the pollution emissions of the plant to acceptable levels. This decision can be made by using a set of criteria for air emissions, water emissions, and solid residues.

Criteria for Air Emissions

Decision criteria as developed by Monsanto Research Corporation (MRC) are generally useful for any industrial source. It must be recognized that pesticide production and formulation processes are in a class by themselves. Pesticides

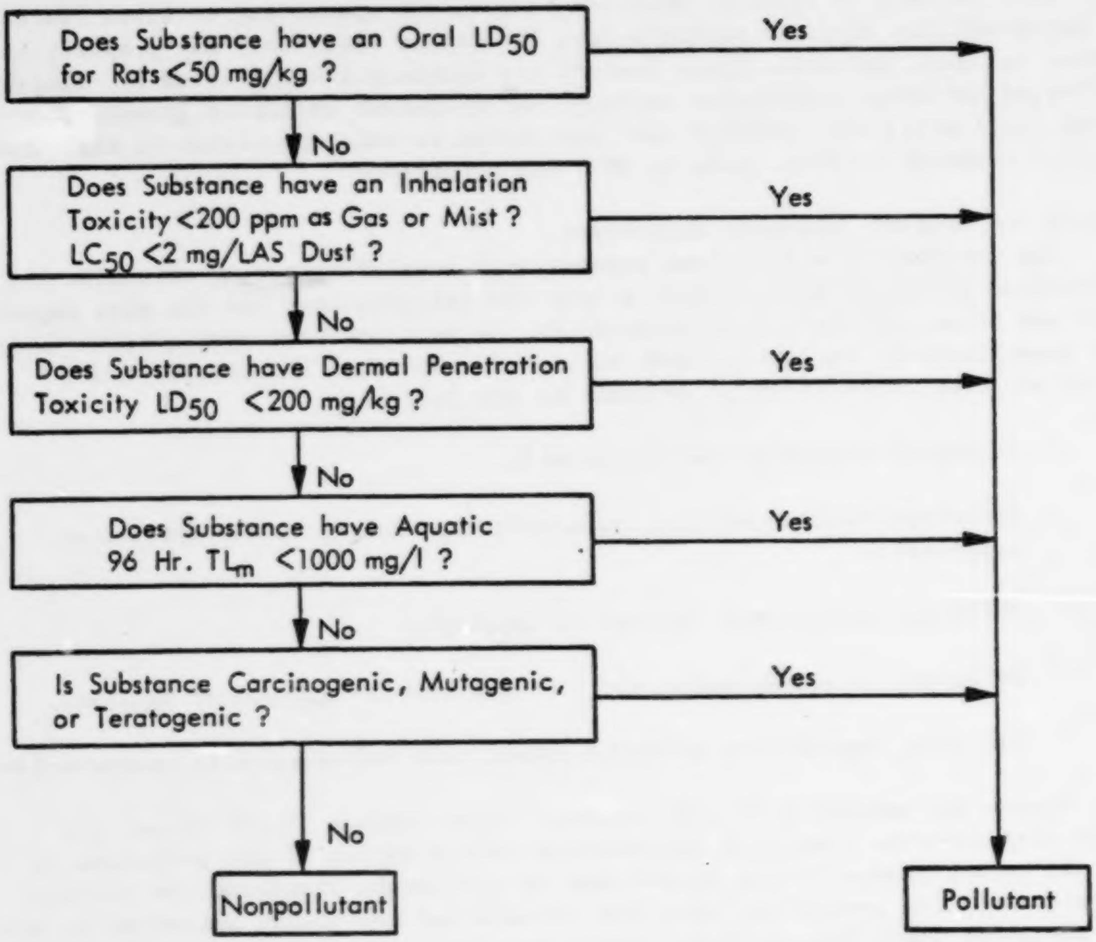

Does Substance have an Oral LD_{50} for Rats <50 mg/kg ?
Yes
No
Does Substance have an Inhalation Toxicity <200 ppm as Gas or Mist ? LC_{50} <2 mg/LAS Dust ?
Yes
No
Does Substance have Dermal Penetration Toxicity LD_{50} <200 mg/kg ?
Yes
No
Does Substance have Aquatic 96 Hr. TL_m <1000 mg/l ?
Yes
No
Is Substance Carcinogenic, Mutagenic, or Teratogenic ?
Yes
No
Nonpollutant
Pollutant

Figure 14. *Decision process for determining the nature of an emission constituent*

are designed to be poisonous to organisms, in effect they are biocides. Thus, one must be especially concerned with the possibility of nontarget organisms being adversely affected. The authors of this report offer a number of considerations which should be used to modify the MRC-developed decision criteria in order to address more fully the toxic character of pesticides.

The additional decision criteria to be considered are derived from the last four factors in Table 7. When the factors are quantified or given limits of acceptability wherever possible from literature data, they may properly be termed decision criteria. Those factors are source pollutant severity, ambient pollutant severity, population exposed, and pollutant emissions growth. The first two factors are combined into one factor in this discussion so that three factors (similar to those used by MRC) are considered.

Source and Ambient Pollutant Severity--

The severity of a pollutant depends upon several important criteria. The discussion presented here considers only the criteria that are the most important and those that have been examined in the past and have been qualitatively and quantitatively determined and reported in published literature. Table 7 gives numerous criteria which we limit to the following.

- Pollutant concentration (measured).
- Pollutant carcinogenicity, mutagenicity, teratogenicity (proven or suspected).
- Pollutant persistence (proven or implied).
- Pollutant bioaccumulation and biomagnification (proven or implied).
- Pollutant degradation products (physically and chemically characterized).

Source and ambient pollutant severity is determined in two steps. The first step involves comparing the measured concentration of the pollutant in the air to acceptable levels established by government standards. No national air standards for pesticides have been established for source emissions by EPA, but Threshold Limit Values (TLVs) have been established in many cases. Similarly, many of the uncommon input chemicals, intermediates, and by-products have no air emission standards, but do have established or provisional TLVs. Therefore, the measured concentrations of these pollutants will be compared to the primary ambient air quality standard (if one exists) or to the TLV of the pollutant.

The comparison is made using the same equations and criteria that MRC uses in their model. That is, source severity, S , is defined as:

$$S = \frac{\overline{X}_{max}}{F} \quad (1)$$

where $\overline{X}_{max}$ is the maximum time average ground level concentration of each pollutant, and F is defined as the primary ambient air quality standard. For pollutants which have no standard (which includes the vast majority of pesticides),

$$F = TLV \cdot 8/24 \cdot 0.01 = \frac{TLV}{300} \quad (2)$$

The factor 8/24 adjusts the TLV to a continuous exposure, and the factor 0.01 is a safety factor. Thus, $\overline{X}_{max}/F$ represents the ratio of the maximum mean ground level concentration of the pollutant to the concentration of the pollutant which is thought to constitute a hazard to man and the environment.

Each pollutant at the pesticide plant under study is subjected to the severity test above. The measured concentration of each pollutant ($\overline{X}_{max}$) is divided by F for that pollutant. If S for one or more pollutants equals or exceeds 1.0, then the source (or sources) of the pollutant is considered to be a definite candidate for pollution control technology development. Those pollutants (which may be all of them in some cases) that have an S value of less than 1.0 require further examination in the second step.

Step 2 considers the other criteria mentioned above, and the effect each criterion has upon modifying the pollutant severity. The importance of each criterion and the effect it produces is as follows.

Carcinogenicity, Mutagenicity, Teratogenicity--

Those pollutants known or suspected to be carcinogens, mutagens, and/or teratogens, are "flagged" for special consideration in source assessment. For these cases, the pollutant source severity, S, shall be assigned a value of 1.0 thus making these pollutants candidates for pollution control technology development. If the pollutant is not known or suspected to have these special toxic properties, the value of S remains unchanged from that derived in Step 1 above.

Examples are given below to illustrate when the severity value for a pollutant is changed to 1.0.

Example	Original S value	Pollutant flagged	New S value
Case 1	S ≥ 1.0	Yes	Unchanged from original value. Pollutant was already a candidate for pollution control technology development.
Case 2	S ≥ 1.0	No	Severity value unchanged.
Case 3	S < 1.0	Yes	Raise S to 1.0. Pollutant is now a candidate for pollution control technology development.
Case 4	S < 1.0	No	Severity value unchanged

Persistence--

If the pollutant has a persistence equal to or greater than 6 months (i.e., ≤ 25% of the pollutant degrades in that period), the value of S is raised to 1.0 in the manner previously described. If the persistence is less than 6 months, the value of S remains unchanged, except in the case in which the degradation products have a more severe impact on man and the environment than the original pollutant. (See discussion below on degradation products.)

Bioaccumulation and Biomagnification--

If the pollutant is known to biomagnify or bioaccumulate, the value of S increases, it is raised to 1.0, and the pollutant becomes a candidate for pollution control technology development.

Degradation Products--

Degradation products must be evaluated with respect to the above three criteria and compared to the original pollutant. If the degradation products are more toxic than the original pollutant, and/or are carcinogenic, mutagenic or teratogenic while the original pollutant is not, then the complexity of the problem increases. An example would be the formation of nitrosamines from atrazine in the Mississippi River.

The relative importance of these criteria are as follows:

Human Effects > Wildlife Effects

$$\left.\begin{array}{l}\text{Carcinogenicity}\\\text{Mutagenicity}\\\text{Teratogenicity}\end{array}\right\} > \text{Persistence} > \text{Bioaccumulation and Biomagnification}$$

Note that each of the above criteria is qualitative (yes or no) and each may affect S by increasing its value but not decreasing its value. At present none of these criteria can be quantitatively evaluated with confidence but are subjective criteria. However, they are important in comparing the relative need for pollution control technology development among various pollutants which have the same S value.

Population Exposed--

The various subfactors of population exposed (human and wildlife) are given in Table 7 and do not modify the original MRC model. The listing in Table 7 only serves to underscore the importance of human population and wildlife exposure to the pollution potential of pesticides and the need for assessment. Obviously, a knowledge of affected population is important to deciding which source problems will be approached first, since resources are limited.

Pollution Emission Growth--

If a pesticide is a viable substitute for other pesticides that have been (or may be) restricted by government regulations, then the production volume of that pesticide will most probably increase in the future. For example, toxaphene production has increased dramatically in the past few years since restrictions have been placed on chlordane, aldrin, heptachlor, and endrin. If the use of a pesticide such as those just mentioned is restricted then the production volume may drop substantially unless an export market exists, e.g., the World Health Organization malaria program utilizing DDT. When considering the future production volume of a pesticide, government regulations, substitutability for other pesticides and other market factors should be considered.

Pesticide plants may have working plans to implement control technology in the future, or anticipated government regulations for the pesticide industry may necessitate control implementation in the future. For example, Montrose Chemical Corporation of Torrance, California, the sole producer of DDT, is conducting extensive research in control technology for their plant. It is important to consider the future production volume and control technologies of a pesticide plant when evaluating the need for control technology development. The future, in this case, should be limited to the next 5 years. These considerations do not affect the MRC model.

In summary, any pesticide active ingredient which has an S value of 1.0 or more is a candidate for pollution control technology implementation, and if no suitable technology exists in practice elsewhere, the technology must be developed. Pesticide active ingredients that are known or suspected carcinogens, mutagens or teratogens should be considered as prime candidates for control technology development, particularly if the pollutants are persistent and biomagnify and bioaccumulate. These pollutants could exist in the environment for years in the air, water, soil or living organisms and cause considerable long-term damages. The same is true for nonpersistent pollutants which degrade into compounds which are toxic carcinogens, mutagens, teratogens, or which are persistent in the environment. Unfortunately, no strict guidelines (other than the S value) can be given in the decision process to determine whether or not a given active ingredient is a candidate for control technology development.

Pesticide Standard for Air--

At present, no standards have been set for pesticide content of ambient air resulting from pesticide manufacture and formulation, or from agricultural uses and other operations. In order to set standards for pesticides in air to cover these operations, monitoring and data collection and interpretation are badly needed.

Recommendations for maximum permissible levels of pesticides in workroom air have been established by the American Conference of Governmental Industrial Hygienists (ACGIH).15/ The permissible levels represent concentrations to which a worker would be exposed for 8 hr, 5 days/week without harmful effect. In reality, the permissible levels are threshold limit values. Table 8 presents threshold limit values of various pesticides.16,17/

Table 8 contains nearly 80 threshold limit values (TLV) for pesticides. However, there are approximately 300 active ingredients listed in the SRI Directory of Chemical Producers of commercial importance which means that recommendations or standards have been set for only 25% of the more important pesticides. Clearly, a much greater effort needs to be expended. The American Conference of Governmental Industrial Hygienists is aware of this monumental task and is actively working on the problem. As a first step the authors of this report suggest those pesticides produced in large quantities, e.g., ≥ 10 million pounds annually, be investigated and a TLV established. Those pesticides produced in the largest quantities for which TLV's have not yet been established include the following:

Pesticide Active Ingredient	Estimated 1974 Production (million lb)
Atrazine	110
Propachlor	45
Alachlor	40
Trichlorophenols	25
Trifluralin	25
Dichloropropene	24
Chloramben	22
DBCP	20
Propanil	15
Simazine	15
Sodium TCA	15
Bromacil	12
Butachlor	10
Bux®	10
Propazine	10

Table 8. THRESHOLD LIMIT VALUES OF VARIOUS PESTICIDES[16,17]

Substance	TLV (mg/m^3)[a]
Abate	10
Aldrin	0.25
Antimony and compounds (as Sb)	(0.5)[b]
Arsenic and compounds (as As)	(0.5)[b]
Azinphos - methyl - skin	0.2
Baygon® (Propoxur)	0.5
Calcium arsenate, as As	1
Captan	5
Captafol (Difolatan®) - skin	0.1[b]
Carbaryl (Sevin®)	5
Carbofuran	0.1
Chlordane	0.5
Chlorinated camphene - skin	0.5
Chloropicrin	0.7
Chlorpyrifos (Dursban®) - skin	0.2[b]
Clopidol (Coyden®)	10[b]
Crag® Herbicide	15
Crufomate (Ruelene®)	50[b]
2,4-D	10
DDT	1
DDVP (Dichlorvos) - skin	1
Demeton® (Systox) - skin	0.1
Diazinon - skin	0.1
Dibrom®	3
Dicrotofos (Bidrin®) - skin	0.25[b]
Dieldrin - skin	0.25
Dinitro-o-cresol - skin	0.2
3,5-Dinitro-o-toluamide (Zoalene®)	5.0[b]
Dioxathion (Delnav®)	0.2[b]
Diquat	0.5
Disyston - skin	0.1
Disulfiram	2
Diuron	10[b]
Dyfonate	0.1
Endosulfan (Thiodan®) - skin	0.1
Endrin - skin	0.1
EPN - skin	0.5
Ethion (Nialate®) - skin	0.4
Ferbam	10

Table 8 (Continued)

Substance	TLV (mg/m^3)[a]
Fensulfothion (Dasanit®)	0.1
Heptachlor - skin	0.5
Lead arsenate	0.15
Lindane (gamma isomer) - skin	0.5
Malathion - skin	10
Manganese and compounds, as Mn	5
Mercury (alkyl compounds) - skin, as Hg	0.01
Mercury (all forms except alkyl), as Hg	0.05
Methomyl (Lannate®) - skin	2.5[b]
Methoxychlor	10
Methyl bromide - skin	60
Methyl demeton - skin	0.5
Methyl parathion - skin	0.2
Monocrotophos (Azodrin®)	0.25[b]
Nicotine - skin	0.5
Nitrapyrin (2-chloro-6(trichloromethyl)pyridine)	10[b]
Paraquat - skin	0.5
Parathion - skin	0.1
Pentachlorophenol - skin	0.5
Phorate (Thimet®) - skin	0.05
Phosdrin (Mevinphos®) - skin	0.1
Phosphorus pentasulfide	1
Picloram (Tordon®)	10[b]
Picric acid - skin	0.1
Pival® (2-Pivalyl-1,3-indandione)	0.1
Plictran® (Tricyclohexyltin hydroxide)	5[b]
Pyrethrum	5
Ronnel (Fenchlorphos)	10
Rotenone (commercial)	5
Sevin® (see Carbaryl)	-
Sodium fluoroacetate (1080) - skin	0.05
Systox (see Demeton)	-
2,4,5-T (2,4,5-Trichlorophenol)	10
TEDP - skin	0.2
TEPP - skin	0.05
Thiram®	5
Tin (organic compounds) - skin	0.1
Toxaphene (see chlorinated camphene)	-
Warfarin	0.1

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[a] Approximate milligrams of substance per cubic meter of air.

[b] 1975 revision or addition.

The term threshold limit value (TLV) is an expression describing permissible toxic levels of different compounds, formerly known as maximum allowable concentrations (MAC). In contrast to the statistically derived function, LD_{50} (lethal dosage for 50% of an infinitely large population of a particular species), the TLV is based on limited experimental and other available data. The TLV is obviously more appropriate for human industrial and occupational exposure restrictions.

Threshold limit values for toxic chemicals are time weighted average concentrations or represent a safe upper limit (ceiling).[17/] Temporary overexposure may be permitted provided that compensation is allowed by an equivalent underexposure during the normal workday. Thus, the TLV refers to levels at which minimum detectable biochemical disturbances occur from which the body functions can reversibly recover. At the TLV, a small percentage of workers may experience some discomfort, and a yet smaller fraction may be affected more seriously (i.e., may require a physician's aid).

At present, the practical unit for assessing potential hazards arising from pesticide manufacturing and formulating operations and determining exposure to the immediate environment surrounding a pesticide plant is the threshold limit value. Table 8 indicates a wide range of permissible levels depending on the specific nature of the pesticide. The absolute range as milligrams of pesticide active ingredient per cubic meter of ambient air covers at least two orders of magnitude from 0.1 mg/m^3 for parathion to 15 mg/m^3 for malathion. Any pollution assessment of the pesticide industry or the examination of air emissions from a particular manufacturing or formulating plant must be based on hard analytical data and referenced to threshold limit values if possible.

Sampling of pesticides emissions in air is a difficult and tedious problem. Generally speaking, traps, screens or impingers must be employed to capture and/or concentrate the pesticide species in order to obtain a statistically reliable sample for subsequent determination. Special devices to perform this important step in source assessment have been devised as early as 1967 at MRI.[18,19/] The MRI impingers have been successfully used by the University of Miami School of Medicine since 1973 in an ongoing pesticide air monitoring program in south Florida.[20-22/] Details of this study may be obtained by consulting the original literature and are briefly summarized in Appendix H under the Florida entry.

The current approach to source assessment of assessing the pollution potential of a toxic product or process does not rely on ambient air sampling. Stack concentrations are determined by sampling with an evacuated heated probe and auxiliary devices such as screens and traps. Plume dispersion model calculations are then employed to determine concentrations of pollutant at varying distances from the source.

Criteria for Water Emissions

Water is generated or used for a number of purposes in pesticide manufacturing and formulating plants. Water generated in the production process is usually contaminated by various concentrations of pollutants. Water usage, consisting of cooling water, boiler water, sanitary wastes, building washdown, air pollution control devices (such as scrubbers), drum and equipment washing, and other uses often generate pollutant contaminated wastewater that must be disposed of.

A pesticide plant can handle contaminated wastewater in a variety of ways. First, the wastewater can be discharged into nearby rivers and streams. Second, the wastewater can be discharged into municipal sewer systems. Third, the wastewater can be handled without discharge by containment, landfilling or contract disposal. The manner in which a pesticide plant handles its wastewater is of the utmost importance in determining the need for control technology development.

Each method for wastewater disposal is examined separately below and the decision criteria for assessing the pollution problem are given in each case.

Discharge into Waterways--

Plants which discharge wastewater into streams and rivers are regulated by law. Before a plant can discharge wastewater into waterways, the plant operators must submit an application for a permit to discharge into navigable waters. They are then given an NPDES permit which specifies the maximum concentrations and maximum daily amounts of pollutants which the plant can legally discharge. Plants operating under a permit must monitor the operation and efficiency of all control and treatment facilities, sample the wastewater discharge for pollutants, and report their findings periodically. Each plant must implement controls to meet the specifications of the permit or they cannot operate.

In general the need for control technology development for wastewater discharged into waterways is not urgent since control technology is already in operation to prevent pollution of the waterways. However, specifications for discharge into waterways may well dramatically change in the future. Requirements for pretreatment before discharge are a very real possibility.

Discharge into Municipal Sewers--

Plants which discharge wastewater into municipal sewers do not need a permit and are not regulated by law. Most of these plants do not monitor or analyze the wastewater effluent, so that many of them may be discharging wastewater contaminated with high concentrations of pollutants. Thus, the need for control technology development at these plants may exist.

It should be noted that when pesticide residues or other toxic substances inactivate the biota in an activated sludge treatment facility, the operation ceases to be effective and raw, untreated sewage may accumulate posing an additional hazard. Such an event apparently happened at Hopewell, Virginia, during the Kepone® tragedy.

In order to determine if the need for control technology development exists, the pollutant concentrations (measured in the detailed source assessment) in the wastewater must be compared to the Proposed Criteria for Water Quality or the Proposed Toxic Pollutant Effluent Standards now in existence. The criterion given here is called the sewer wastewater severity, S_{sw}, and is defined as:

$$S_{sw} = \frac{C_{measured}}{C_{std}}$$

Where $C_{measured}$ is the maximum concentration of each pollutant measured in a 24-hr period, and C_{std} is the least allowable concentration permitted by one of the two above standards.

When S_{sw} is greater than 1.0 for one or more of the pollutants in the wastewater, the process is definitely a candidate for control technology development. If no pollutants in the stream discharged to the sewer have an S_{sw} greater than 1.0, then the need for pollution control technology development does not exist.

Zero Discharge--

Wastewater which is not discharged into waterways or sewers is usually handled in one of three ways: (a) placed in evaporation ponds; (b) placed in landfills; or (c) disposed of by contract disposal firms. The contents of wastewater handled by these methods are usually unknown, and in many cases the wastewater contains one or more pollutants which may cause environmental damage.

Pollutants discharged into a lined evaporation pond may evaporate into the air causing an air emissions problem, or are eventually removed from the pond as sludge causing a solid residue problem. If the pond is not lined, the pollutants may leach into the soil and become transported away from the pond into the surrounding environment. Any process which uses an evaporative pond operation must be subjected to examination for pollution problems.

The concentration of pollutants in the ambient air above and around the pond should be sampled and analyzed. The measured concentrations of pollutants in the air should then be subjected to the criteria for air emissions given previously to determine if the need for control technology development exists.

Sludge from the pond should be properly disposed of to prevent contamination of the air, groundwaters, and nearby waterways. Where possible, the air above and around sludge dumps, the water in nearby waterways, and groundwater should be sampled and analyzed. The pollutant should then be subjected to the criterion for water emissions for discharge into municipal sewers, and criterion for air emissions, given previously, to determine if the need for control technology development exists. Similarly, the air, the nearby waterways, and the groundwater around unlined evaporation ponds should be sampled and analyzed where possible, and the pollutants from these sources should be subjected to the criterion given previously for wastewater discharge into municipal sewers (S_{sw}) and for air emissions.

Pollutants discharged into landfills should be subjected to the same analyses and criteria as pollutants discharged into unlined evaporation ponds. Soil samples should be taken in landfills to determine the concentration of pollutants in the soil. No strict guidelines have been developed for pollutant concentrations in soil; comparison to pollutant concentrations normally found in agricultural areas treated with the same pesticide might be used as a rough guideline for determining whether or not the landfill soil concentration is too high.

Pollutants that are disposed of by contract disposal firms fall outside the scope of this study, but the methods these firms use to ultimately dispose of the wastewater should be examined and analyzed for possible environmental insult.

Criteria for Solid Residues

Solid residues are generated at pesticide manufacturing and formulating plants in a variety of ways. Some of the more common sources are:

- By-products of the production or formulating process;
- Contaminated drums, packaging materials, and other containers;
- Sludge from evaporation ponds;
- Ashes and other residues from incinerators; and
- Off-specification batches of solid product.

These solid residues are usually highly contaminated with pesticide active ingredients, pesticide degradation products, and other process pollutants. Escape of these residues into the environment could cause significant damage.

Solid residues are usually handled in one of four ways: (a) landfilling; (b) incineration; (c) chemical treatment; or (d) contract disposal. The pollution potential of each of these methods is examined separately below, and the decision criteria for assessing the pollution problem are given in each case.

Landfilling--

Solid residues placed in a landfill are subject to transport away from the site through such mechanisms as vaporization, runoff, and leaching. When considering the pollution potential of toxic solid residues disposed of in landfills, the following properties of the pollutants are important.

1. Persistence

2. Ultimate fate in terms of biological and physical transformation products

    a. Toxicity
    b. Carcinogenicity, mutagenicity, teratogenicity

3. Transport characteristics

    a. Volatility
    b. Leachability
    c. Solubility
    d. Adsorption on and absorption in soil

Solid residues which are persistent or degrade into persistent hazardous substances can remain a potential threat to the environment for many years. If the landfill does not properly contain these substances, they may be slowly released into the environment through leaching and volatilization or they may be catastrophically released in large amounts with the occurrence of a flood, earthquake or other natural event.

The air, nearby waterways, groundwater, local soil, and the landfill deposits themselves should be subjected to analyses to determine the nature and concentrations of pollutants in and around solid waste landfills. The properties of the pollutants described above should be noted for each pollutant detected so that the magnitude of the pollution potential can be evaluated. Those pollutants which are persistent or degrade into persistent hazardous substances and are readily subject to transport away from the landfill must be considered threats to the environment both in the short term and the long term.

No strict guidelines have been developed for concentrations of pollutants that represent an imminent threat to man and the environment through the depositing of solid residues in landfills. However, if the criteria above are taken into consideration and the concentrations of pollutants are measured, a reasonable assessment can be made as to the potential for present and future environmental insult. When this potential seems unreasonably high or threatening, the need for control technology development may be foreseen.

Incineration--

The effluent gases from incinerators which dispose of solid wastes from pesticide plants should be analyzed for the nature and concentrations of the effluents' constituents. The measured concentrations of any pollutant detected should be subjected to the criteria for air emissions given previously. The incinerator ash should also be sampled for pollutants, and the method of ash disposal should be evaluated.

If any pollutants are emitted from the incinerator that have a source severity, S, greater than 1.0, then the incinerator operation is a definite candidate for pollution control technology development. If S is less than 1.0 for all air pollutants emitted, then those pollutants should be subjected to further examination as previously defined in the criteria for air emissions section.

Chemical Treatment--

Chemical treatment facilities for the detoxification of toxic solid residues should be analyzed and evaluated for their effectiveness in rendering the toxic solids nonhazardous. If the treatment process is ineffective or only partially effective in transforming the pollutants into nonpollutants, then the need for control technology development exists.

Contract Disposal--

Solid residues disposed of by contract disposal firms fall outside the scope of this study, but the methods these firms use to ultimately dispose of the solid wastes should be examined and analyzed for possible environmental insult. Determining the disposal firms' awareness as to the nature and composition of the solid wastes is an important aspect of this analysis since those firms that are not aware of the type of solid wastes they handle for pesticide plants may be negligent in properly handling those wastes.

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SECTION 4

SELECTION OF INDIVIDUAL PESTICIDES FOR FUTURE DETAILED SOURCE ASSESSMENT

This section of the report presents the methodologies and information bases which were used to select six candidate pesticides active ingredients for detailed source assessment.* The methodologies used began by limiting the pesticides considered to 82 major pesticides whose 1974 production volumes were estimated and for which the needed quantitative data were available. Next, a priority rating system was developed to rank numerically the 82 pesticides in the order of their importance as candidates for assessment. The priority rating system was composed of six separate criteria which affect the pollution potential of a pesticide.

The priority ratings for the 82 major pesticides were then used to select candidate pesticides utilizing three alternate selection methods.

Selection Method No. 1 consisted of ranking the 82 pesticides in a numerical priority order using the priority rating system, and selecting the top six pesticides on the list as the best candidates for detailed source assessment. The six pesticides selected by this method in order of priority rating were DDT, chlordane, heptachlor, MSMA, endrin, and PCP (and sodium salts). Five of the six pesticides are organochlorine compounds; these six pesticides therefore were not representative of pesticides in general.

Selection Method No. 2 consisted of ranking the pesticides in a numerical priority order using the priority rating system, but with the pesticides segregated into their 10 chemical classes or groups instead of considering them all together. This type of segregation was considered in order to insure better representation of all chemical classes of pesticides. Candidate pesticides were selected by this method representing all 10 chemical groups. The 10 candidate pesticides selected in order of priority rating were DDT, chlordane, MSMA, dinoseb, parathion or methyl parathion, carbaryl, captan, atrazine or simazine, monuron, and alachlor.

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* An alternative methodology and associated information base for selecting the "best" plant sites for assessment is given in Appendix K.

Selection Method No. 3 consisted of selecting pesticides based not only on high priority rankings by chemical classes, but also on the characteristics of the plant sites involved. Pesticides, which were manufactured by plant(s) manufacturing other pesticides with high priority ratings, and pesticides which were manufactured by fewer plants than alternative pesticides with equal or similar priority ratings were selected. The pesticides were segregated by chemical groups in this method, and the list of 27 candidate pesticides was developed.

Table 9 contains a summary of candidate pesticide active ingredients as selected by the three alternate methods and is given for purposes of comparison on an individual pesticide basis by methodology, chemical classification, and priority rating. Two pesticides, DDT and MSMA, are common to all three methodologies and five highly rated pesticides, parathion, carbaryl, chlordane, heptachlor, and endrin, are common to two methodologies all of which reinforces their importance in any final selection of pesticides. Two pesticides, PCP (and salts) and dinoseb appear only once in the tri-selection process but are defensible on the basis of total priority rating values. Other pesticides appearing one or two times are relatively unimportant due to their low priority ratings.

Utilizing the composite results from all three methodologies, the following six pesticides are suggested as candidates for detailed source assessment: DDT, chlordane, MSMA, PCP and salts, parathion, and carbaryl.

The three selection methodologies and their application in selecting these six pesticides are discussed in detail in the following paragraphs. This discussion is divided into four sections.

- The Limited List of Pesticides and Pesticide Groups
- Estimated 1974 Production Volumes of Synthetic Organic Pesticides;
- Pesticide Priority Rating System; and
- Selection of the Six Candidate Pesticides.

THE LIMITED LIST OF PESTICIDES AND PESTICIDE GROUPS

The selection of individual pesticides as candidates for detailed source assessment involved limiting the number of pesticides to be considered at the outset, since about 1,200 active pesticidal ingredients are currently being manufactured, and the objective was to select only six pesticides from the entire pesticides industry. The initial compilation included only synthetic organic pesticides of an estimated 1974 production volume which equaled

Table 9. SUMMARY OF CANDIDATE PESTICIDES AS SELECTED BY THREE ALTERNATE METHODS

Pesticide chemical class[a]	Method No. 1[b]	Method No. 2[c]	Method No. 3[d]
A	✓DDT (21)	✓DDT (21)	✓DDT (21)
	✓PCP and salts (15)	-	-
B	-	✓Parathion (12), or	✓Parathion (12)
	-	Methyl parathion (12)	Methyl paration (12)
	-	(Tie)	Disulfoton (10)
	-	-	Fensulfothion (10)
C	-	✓Carbaryl (11)	✓Carbaryl (11)
			Aldicarb (9)
D	-	Atrazine (8), or	Atrazine (8)
	-	Simazine (8)	Simazine (8)
	-	(Tie)	Propazine (7)
E	-	Alachlor (6)	Alachlor (6)
	-	-	Propachlor (5)
	-	-	Butachlor (4)
F	✓MSMA (16)	✓ MSMA (16)	✓MSMA (16)
		-	DSMA (13)
	-	-	Cacodylic acid (10)
G	-	Captan (9)	Captan (9)
	-	-	Folpet (5)
	-	-	CDAA (4)
H	✓Chlordane (18)	✓Chlordane (18)	-
	Heptachlor (17)	-	Heptachlor (17)
	Endrin (15)	-	Endrin (15)
I	-	Monuron (8)	Monuron (8)
	-	-	Diuron (7)
	-	-	Bromacil (6)
	-	-	Terbacil (3)
J	-	Dinoseb (12)	-
	-	-	Trifluralin (10)
	-	-	Benefin (4)
Total candidate pesticides	6	10	27

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a/ A = Chlorinated hydrocarbons; B = organophosphorus compounds; C = carbamates D = triazines; E = anilides; F = organoarsenicals and organometallics; G = Other nitrogenous compounds; H - Diene-based compounds; I = ureas and uracils; J = nitrated hydrocarbons.

b/ Method No. 1 ranks pesticides by priority rating. Rating values are given in parentheses.

c/ Method No. 2 ranks pesticides by priority rating within the 10 chemical classes.

d/ Method No. 3 ranks pesticides by priority rating, by chemical class, and by manufacturing plant site considerations.

Note: Check marks (✓) indicate the six final pesticides selected for detailed source assessment.

or exceeded 2 million pounds (hereafter called the major pesticides). This limitation was made for four primary reasons: (a) a list of some 1,200 pesticides included many pesticides for which no quantitative data are available; (b) many pesticidal chemicals, e.g., inorganics and natural organics, had many other nonpesticidal uses, and the pesticidal usage was small in relationship to the nonpesticidal usage of these chemicals, so they were excluded from consideration; (c) most of the pesticides for which quantitative and qualitative data exist were those pesticides produced in large quantities, and as a matter of practicality the production cutoff point was set at 2 million pounds in 1974; and (d) the major pesticides represent the vast majority of pesticides produced by the pesticides industry, and examination of those pesticides to the exclusion of the smaller volume pesticides should not materially affect a valid selection of six candidates for detailed source assessment.

Next, the major pesticides were segregated into 10 chemical groups (plus a miscellaneous group) composed of pesticides that are similar in chemical composition, and that are manufactured by similar production techniques. This was done to select six pesticides that were dissimilar in chemical composition and were manufactured with different production techniques in the event that the priority rating system developed for this study selected six similar pesticides that would represent a narrow segment of the entire pesticides industry. The chemical groups used in this study were:

A. Chlorinated hydrocarbons, e.g., DDT, PCP;

B. Organophosphorus compounds, e.g., parathion;

C. Carbamates, e.g., carbaryl;

D. Triazines, e.g., atrazine;

E. Anilides, e.g., alachlor;

F. Organoarsenicals and organometallics, e.g., MSMA;

G. Other nitrogenous compounds, e.g., captan;

H. Diene-based, e.g., chlordane;

I. Ureas and uracils, e.g., monuron;

J. Nitrated hydrocarbons, e.g., dinoseb; and

K. All others, e.g., methyl bromide.

Pesticides which were placed within a group are chemically similar to other members of that group with the exception of the all others group. Pesticides within a group are manufactured by production techniques similar to other members of that group with the exception of the chlorinated hydrocarbon, other nitrogenous compounds, and all others groups. Thus, each member of a chemical group is somewhat representative of the other members, at least chemically and in production technique, with the exceptions just noted.

The limited list of synthetic organic pesticides, by chemical group, is given in the next section, which discusses the 1974 production volume of those synthetic organic pesticides.

ESTIMATED 1974 PRODUCTION VOLUMES OF SYNTHETIC ORGANIC PESTICIDES

The 1974 production volumes of the major synthetic organic pesticides were estimated for this study both to develop a limited list of pesticides and to provide part of the necessary data for ranking the pesticides in a priority rating system (discussed in the next section). The estimates were both difficult and tedious to make, since data on the production volumes of pesticides were almost completely unavailable on an individual compound basis and those which were available left much to be desired.

The basic source of pesticide data for years has been the U.S. Tariff Commission's (now the U.S. International Trade Commission) "Synthetic Organic Chemicals, United States Production and Sales," which contains a two-page tabular summary on "Pesticides and Related Products." This report, issued annually but 2 years after the subject year, is preceded by a preliminary issue of the "Pesticides and Related Products" section of about 10 pages which lists the manufacturing companies who reported production of each synthetic organic pesticidal compound, in addition to the tabular summary. The tabular data are categorized under cyclic and acyclic with subdivisions of (a) fungicides, (b) herbicides and plant hormones, (c) insecticides, rodenticides, and fumigants and soil conditions, plus general totals for benzenoid and nonbenzenoid chemicals.

Table 10 shows the U.S. production of synthetic organic pesticides, by category, in 1974 as reported by the U.S. International Trade Commission[1] and is the basic data from which the production estimates were developed in this study. This table, however, is obviously insufficient for estimating the production volumes of individual pesticides, so the next step was to estimage the 1974 U.S. production of synthetic organic pesticides by chemical group as shown in Table 11. The estimates shown in this table are based upon the data in Table 10, MRI pesticide production estimates, and current knowledge regarding various segments of the pesticides industry based in part on confidential sources. The estimates shown in Table 11 are believed to be accurate to within ± 10%.

Table 10. U.S. PRODUCTION OF SYNTHETIC ORGANIC PESTICIDES, BY USAGE CATEGORY, IN 1974

Pesticide usage categories	1974 Production (millions of pounds)
Fungicides	
PCP and sodium salts	52.4
Naphthenic acid, copper salt	2.0
Other cyclic fungicides	70.1
Dithiocarbamic acid salts	35.4
Other acyclic fungicides	2.8
Total fungicides	162.7
Herbicides and plant hormones	
Maleic hydrazide	5.8
2,4-D acid, dimethylamine salt	14.5
Other cyclic compounds	467.4
All acyclic compounds	116.5
Total herbicides and plant hormones	604.2
Insecticides, rodenticides, soil conditioners and fumigants	
Aldrin-toxaphene group	141.7
Methyl parathion	51.4
Other cyclic organophosphorus insecticides	56.4
Methoxychlor	3.2
Other cyclic insecticides and rodenticides	160.5
Methyl bromide	30.5
Acyclic organophosphorus insecticides	78.8
Chloropicrin	4.8
Other acyclic insecticides, rodenticides, soil conditioners, and fumigants	123.0
Total	650.3
Total synthetic organic pesticide production, 1974	1,417.2

Source: U.S. International Trade Commission (1975).

Table 11. U.S. PRODUCTION OF SYNTHETIC ORGANIC PESTICIDES, BY CHEMICAL GROUPS, IN 1974

Chemical group	Estimated 1974 production (millions of pounds)	Estimated percentage of total production (rounded)
Chlorinated hydrocarbons	460	33
Organophosphorus compounds	200	14
Carbamates	150	10
Triazines	150	10
Anilides	110	8
Other nitrogenous compounds	70	5
Organoarsenicals and organometallics	55	4
Diene-based compounds	40	3
Ureas and uracils	40	3
Nitrated hydrocarbons	40	3
All others	102	7
Total	1,417	100

Source: MRI estimates (February 1976).

Next, the 1974 production volumes of individual pesticides within each chemical group were estimated and are shown in Table 12. These estimates were obtained from limited information on a few pesticides from published sources (shown at the end of the table), from an update of 1972 production estimates made previously by MRI,[2] and from information obtained from other studies performed at MRI. The authors believe these estimates have the following accuracies depending on the volume range.

Volume Range	Accuracy
> 20 million pounds	± 10%
10-20 million pounds	± 10-20%
< 10 million pounds	± 20-30%

The pesticides listed in Table 12 formed the limited list which was subjected to evaluation in this study, and all subsequent selections of candidate pesticides for detailed source assessment consider only those pesticides shown in Table 12 (for reasons previously given). The production estimates shown in the table were used in this study to assign the numerical value to the 1974 production volume criteria in the pesticide priority rating system described in the next section.

PESTICIDE PRIORITY RATING SYSTEM

The pesticide priority rating system developed for this study involved making assumptions about the relative pollution potential of one pesticide in comparison to other pesticides as certain criteria are applied to each pesticide. The only pesticide criteria considered in the rating system developed here were those for which quantitative (or qualitative) data were currently available. Those criteria were: (a) estimated 1974 production volume, (b) acute mammalian toxicity (oral LD_{50}-rats), (c) suspected carcinogenicity, mutagenicity, and/or teratogenicity, (d) toxicity to fish, birds, and invertebrates, (e) persistence, and (f) biomagnification, bioaccumulation, and environmental mobility.

Each criterion was assumed to be equally important in affecting the pollution potential of a pesticide since there was no quantitative method available for weighing the importance of each of these criteria against one another. The numerical values assigned to each criterion were assumed to be additive to arrive at a total rating for each pesticide, and each criterion was evaluated on a numerical scale of zero to four. Each criterion is discussed below, regarding the numerical rating scale for each criterion, the assumptions made to develop each rating scale, and the information sources used to determine the numerical value of each criterion for each of the pesticides given a priority rating.

Table 12. ESTIMATED U.S. PRODUCTION AND TOXICITY RATINGS OF MAJOR INDIVIDUAL SYNTHETIC ORGANIC PESTICIDES, BY CHEMICAL GROUP, IN 1974

Group designation	Chemical group	Pesticide	Estimated 1974 production (million lb)	Acute mammalian toxicity rating
A	Chlorinated hydrocarbons	Toxaphene	110	2
		DDT	60[a]	2
		2,4-D acid, esters, salts	55[b]	2
		PCP and sodium salts	52[c]	3
		Trichlorophenols	25	1
		Dichloropropene	24	2
		Chloramben	22	1
		DBCP	20	2
		Sodium TCA	15	1
		Dalapon	5	1
		Silvex	5	1
		Dicamba	5	1
		Dicofol	4	1
		Methoxychlor	3	1
		DCPA	3	1
		Endothall	3	2
		Lindane and BHC	2	2
		2,3,6-TBA	2	1
		All others	45	-
			460	
B	Organophosphorus compounds	Methyl parathion	51[c]	4
		Malathion	30	1
		Parathion	17	4
		Diazinon	12	2
		Disulfoton	10	3
		Phorate	10	4
		Monocrotophos	7	3
		Fensulfothion	6	4
		Merphos	5	2
		DEF®	5	2
		Guthion®	5	3
		Dyfonate	3	4
		Ethion	3	3
		Ronnel	3	1
		Naled	3	2
		Dimethoate	3	2
		DDVP	2	2
		Carbofenthion	2	3
		All others	23	-
			200	

Table 12. (Continued)

Group designation	Chemical group	Pesticide	Estimated 1974 production (million lb)	Acute mammalian toxicity rating
C	Carbamates	Carbaryl	58	2
		Maneb	12	1
		Bux®	10	2
		Carbofuran	10	3
		Methomyl	10	3
		Butylate	8	1
		Zineb	7	1
		EPTC	6	1
		Nabam	5	2
		Vernolate	5	1
		Aldicarb	5	4
		Benomyl	4	0
		Polyram	3	0
		All others	7	-
			150	
D	Triazines	Atrazine	110	1
		Simazine	15	1
		Propazine	10	0
		All others	15	-
			150	
E	Anilides	Propachlor	45	1
		Alachlor	40	1
		Propanil	15	1
		Butachlor	10	1
			110	
F	Organoarsenicals and organometallics	MSMA	35	3
		DSMA	10	1
		Cacodylic acid	3	1
		Copper naphthenates	2[c/]	1
		All others	5	-
			55	
G	Other nitrogenous compounds	Captan	20	2
		CDAA	7	1
		Maleic hydrazide	6[c/]	1
		Nitralin	3	1
		Picloram	3	1
		Captafol	3	1
		Folpet	3	0
		All others	25	-
			70	

Table 12. (Concluded)

Group designation	Chemical group	Pesticide	Estimated 1974 production (million lb)	Acute mammalian toxicity rating
H	Diene-based compounds	Chlordane	15[d]	2
		Aldrin	10[e]	3
		Endrin	3	4
		Heptachlor	3[d]	3
		Endosulfan	3	3
		All others	6	-
			40	
I	Ureas and uracils	Bromacil	12	1
		Diuron	10	2
		Fluometuron	5	2
		Linuron	3	1
		Terbacil	3	0
		Monuron	3	1
		All others	4	-
			40	
J	Nitrated hydrocarbons	Trifluralin	25	2
		Chloropicrin	5[c]	2
		Dinoseb	3	3
		Benefin	3	1
		All others	4	-
			40	
K	All others	Methyl bromide	31[c]	-
		Miscellaneous	71	-
			102	
	Total all synthetic organic pesticides		1,417[c]	

Source: MRI estimates (February 1976).

[a] Based upon DDT exports of 56.4 million pounds (100% basis) in 1974 as reported in The Pesticide Review, 1974 (1975) (Ref. 3).

[b] Based upon report in Chemical Marketing Reporter, January 5, 1976. (Ref. 4)

[c] Based upon data published by U.S. International Trade Commission (1975). (Ref. 1)

[d] Based upon report in Chemical Marketing Reporter, July 14, 1975. (Ref. 5)

[e] Based upon report in Chemical Marketing Reporter, April 14, 1975. (Ref. 6)

Criterion of Estimated 1974 Production Volume

The numerical rating system for the estimated 1974 annual production volume assigns a value of 0 to 4 to each pesticide based upon the production estimates given in Table 12. The scale used to assign these numerical values was:

Rating	Estimated 1974 production volume (millions of pounds)
0	< 1
1	1-5
2	6-9
3	10-24
4	25 or more

This scale was developed for this study and is based upon two important assumptions. First, the pollution potential of a pesticide increases as the quantity of that pesticide produced increases. And second, the pollution potential of a pesticide does not increase in direct proportion to the quantity produced. It is assumed that the greater the amount of a given pesticide a plant produces, the greater is its potential revenue, and, therefore, the greater the financial capability of the plant operators for installing pollution control devices to mitigate the pollution caused by the manufacture of the pesticide. (This assumption should not be construed to mean that this is the actual case, but merely that larger plants will have a greater propensity to install pollution control technology.)

Criterion of Acute Mammalian Toxicity

The numerical rating scale used for the acute mammalian toxicity of pesticides was one that is recongnized by various authors on the subject,[7] and was:

Rating	Classification	Oral LD_{50}-rats (mg/kg)
0	Insignificantly toxic	> 5,000
1	Slightly toxic	500-5,000
2	Moderately toxic	50-499
3	Highly toxic	5-49
4	Extremely toxic	< 5

The acute mammalian toxicity for individual pesticides is shown in Appendix C. These data were used to assign each pesticide listed in Table 12 a numerical value for acute mammalian toxicity according to the above scale.

Criterion of Special Toxicity

The term special toxicity was used here to designate carcinogenicity, mutagenicity, and teratogenicity. A pesticide which was suspected to have any of these properties was given a rating of 4; all other pesticides were given a rating of zero.

Each pesticide evaluated was determined to have, or not have, special toxicity based on the information presented in Appendices C and I.

Criterion of Wildlife Toxicity

A numerical rating scale of 0 to 4 was used to account for the degree of toxicity a pesticide had toward fish, birds, and invertebrates. The greater the toxicity to and the greater the number of different species of wildlife affected, the higher the numerical toxicity rating assigned to the subject pesticide.

The numerical values assigned to each pesticide are the same values developed in a 1974 MRI report by von Rümker, Lawless, and Meiners,[8] and the appropriate pages of that report from which the data were taken are shown in Appendix J. This information base is dated but was the best source of data available.

Criterion of Persistence

Pesticide persistence varies with environmental conditions, and sometimes the variation is substantial. Data on pesticide persistence were sometimes unavailable or given in a wide range, and had to be estimated. The following scale was used and is taken from the 1974 MRI report cited above:

Rating	Time (in months) for 75-100% disappearance
0	< 1
1	1-3
2	4-10
3	11-18
4	> 18

The source of information used to assign each pesticide a persistence rating is shown in Appendix J and was also taken from the 1974 MRI report.

Criterion of Bioaccumulation, Biomagnification, and Mobility

Pesticides are more detrimental to the environment if they biomagnify, bioaccumulate, and move throughout the environment. A rating scale of 0 to

4 was used to indicate the degree to which pesticides display these properties in the environment. A zero rating indicated that the pesticide biomagnifies or bioaccumulates to only a limited extent, or not at all, and was relatively immobile in the environment. A rating of 4 indicated that numerous species of wildlife and plants biomagnify and/or bioaccumulate the pesticide, and that the pesticide was subject to transport throughout the environment. Ratings of 1 to 3 simply indicated a matter of degree.

The source of information used to assign each pesticide a rating for this criterion is shown in Appendix J, which was taken from the 1974 MRI report.

SELECTION OF THE FINAL SIX CANDIDATE PESTICIDES

The priority rating system described above was used in the selection of six candidate pesticides for detailed source assessment by ranking all of the pesticides (except methyl bromide in the miscellaneous group) in the limited list (Table 12). Three alternate methods of selection were used to show which pesticides were candidates for detailed source assessment, depending upon the selection methodology and approach used. Each alternate method and the pesticide candidates chosen by each method are discussed as follows.

Alternate Selection Method No. 1

The first selection method consisted of ranking all of the pesticides in a numerical priority order using the priority rating system, and selecting the first six pesticides on the list as the best candidates for detailed source assessment. Table 13 shows the priority ranking of the individual synthetic organic pesticides evaluated in this study. The sources of information used to provide the numerical values given in the table were previously described.

The top six pesticides in the table are DDT, chlordane, heptachlor, MSMA, endrin, and PCP (and sodium salts). Aldrin was excluded from consideration because it is no longer produced in the United States.[9] These six pesticides are the candidates for source assessment selected by this method. Note that DDT and PCP (and salts) are chemically similar and that chlordane, heptachlor, and endrin are likewise chemically similar.

Alternate Selection Method No. 2

The second selection method consisted of ranking all of the pesticides in a numerical priority order using the priority rating system, but with the additional stipulation that the pesticides were segregated into the 10 chemical groups. The pesticides were segregated by chemical group so that the highest rated pesticide from each group could be selected. This method was chosen to avoid selecting six pesticides which were similar in chemical composition and manufactured in a similar manner.

Table 13. PRIORITY RANKING OF INDIVIDUAL SYNTHETIC ORGANIC PESTICIDES FOR DETAILED SOURCE ASSESSMENT[a]

Rank-Order		Criteria and numerical rating						
	Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	Total priority rating
1.	DDT	4	2	4	3	4	4	21
2.	Chlordane	3	2	4	1	4	4	18
3.	Heptachlor	1	3	4	1	4	4	17
4.	Aldrin[b]	3	3	0	2	4	4	16
5.	MSMA	4	3	4	0	3	2	16
6.	Endrin	1	4	0	3	3	4	15
7.	PCP and Sodium	4	3	4	1	3	0	15
8.	DSMA	3	1	4	0	3	2	13
9.	Toxaphene	4	2	0	2	2	2	12
10.	Lindane and BHC	1	2	0	1	4	4	12
11.	Parathion	3	4	0	4	0	1	12
12.	Methyl parathion	4	4	0	3	0	1	12
13.	Dinoseb	1	3	4	3	1	0	12
14.	Trichlorophenols	4	1	4	0	2	0	11
15.	Phorate	3	4	0	3	1	0	11
16.	Carbaryl	4	2	4	0	0	1	11
17.	Diazinon	3	2	0	3	1	1	10
18.	Disulfoton	3	3	0	3	1	0	10
19.	Fensulfothion	2	4	0	3	1	0	10
20.	Carbofuran	3	3	0	3	0	1	10
21.	Cacodylic acid	1	1	4	0	3	1	10
22.	Trifluralin	4	2	0	3	1	0	10
23.	Dyfonate®	1	4	0	3	1	0	9
24.	Captan	3	2	4	0	0	0	9
25.	Maneb	3	1	4	0	1	0	9

Table 13. (Continued)

Rank-Order Pesticide	Criteria and numerical rating						Total priority rating
	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	
26. Methomyl	3	3	0	3	0	0	9
27. Aldicarb	1	4	0	4	0	0	9
28. Monocrotophos	2	3	0	3	0	0	8
29. Atrazine	4	1	0	0	2	1	8
30. Simazine	3	1	0	0	3	1	8
31. Endosulfan	1	3	0	1	2	1	8
32. Monuron	1	1	4	0	2	0	8
33. Silvex	1	1	4	0	1	0	7
34. Malathion	4	1	0	1	0	1	7
35. Merphos	1	2	4	0	0	0	7
36. Carbofenthion	1	3	0	3	0	0	7
37. Ronnel	1	1	4	1	0	0	7
38. Dimethoate	1	2	4	0	0	0	7
39. Maleic hydrazide	2	1	4	0	0	0	7
40. Diuron	3	2	0	0	2	0	7
41. Zineb	2	1	4	0	0	0	7
42. Nabam	1	2	4	0	0	0	7
43. Propazine	3	0	0	0	4	0	7
44. Picloram	1	1	0	0	4	0	6
45. Captafol	1	1	4	0	0	0	6
46. Nitralin	1	1	0	3	1	0	6
47. Bromacil	3	1	0	0	2	0	6
48. 2,4-D, acids, esters, and salts	4	2	0	0	0	0	6
49. Methoxychlor	1	1	0	1	1	2	6
50. DDVP	1	2	0	3	0	0	6
51. Guthion®	1	3	0	1	1	0	6
52. Alachlor	4	1	0	0	1	0	6

Table 13. (Continued)

Rank-Order		Criteria and numerical rating						
	Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	Total priority rating
53.	Dichloropropene	3	2	0	0	0	0	5
54.	Chloramben	3	1	0	0	1	0	5
55.	DBCP	3	2	0	0	0	0	5
56.	Sodium TCA	3	1	0	0	1	0	5
57.	Dicofol	1	1	0	0	2	1	5
58.	Folpet	1	0	4	0	0	0	5
59.	Fluometron	1	2	0	0	2	0	5
60.	Chloropicrin	1	2	0	1	1	0	5
61.	Bux®	3	2	0	0	0	0	5
62.	Polyram	1	0	4	0	0	0	5
63.	Propachlor	4	1	0	0	0	0	5
64.	Propanil	3	1	0	0	0	1	5
65.	DCPA	1	1	0	0	2	0	4
66.	2,3,6-TBA	1	1	0	0	2	0	4
67.	Ethion	1	3	0	0	0	0	4
68.	Naled	1	2	0	1	0	0	4
69.	Butylate	2	1	0	0	1	0	4
70.	EPTC	2	1	0	0	1	0	4
71.	Butachlor	3	1	0	0	0	0	4
72.	CDAA	2	1	0	0	1	0	4
73.	Linuron	1	1	0	0	2	0	4
74.	Benefin	1	1	0	0	2	0	4
75.	Dalapon	1	1	0	0	1	0	3
76.	Endothall	1	2	0	0	0	0	3
77.	Dicamba	1	1	0	0	1	0	3
78.	DEF®	1	2	0	0	0	0	3
79.	Vernolate	1	1	0	0	1	0	3

Table 13. (Concluded)

		Criteria and numerical rating						
	Rank-Order Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	Total priority rating
80.	Copper naphthenates	1	1	0	0	1	0	3
81.	Terbacil	1	0	0	0	2	0	3
82.	Benomyl	1	0	0	1	0	0	2

---

[a] Those pesticides which have the same total priority rating (for example, aldrin and MSMA) are not arranged in any particular order.

[b] Aldrin is no longer produced in the United States.

Table 14 shows the priority ranking of the individual synthetic organic pesticides by chemical group. The highest ranked pesticide(s) in each group was then selected as a candidate for detailed source assessment so that the entire pesticides industry was represented by pesticides of dissimilar chemical compositions and dissimilar manufacturing techniques. The 10 pesticides selected in this manner were DDT, parathion or methyl parathion, carbaryl, atrazine or simazine, alachlor, MSMA, captan, chlordane, monuron, and dinoseb. These pesticides were further reduced to six in number by dropping atrazine, alachlor, captan, and monuron from the list since these four pesticides had a lower priority rating than the other six pesticides, and since each of the four pesticides eliminated represented the four chemical groups with the lowest overall priority rating. (Methyl parathion and simazine were previously eliminated since they are equivalent in priority rating to parathion and atrazine, respectively.) Thus, the six pesticides selected by this method were DDT, parathion, carbaryl, MSMA, chlordane, and dinoseb.

Alternate Selection Method No. 3

This method departs from the first two methods in that it not only considers the priority rating of the pesticides but also takes into account the plants which manufacture the pesticides. This approach was taken as an alternative to the other two methods since any source assessment must necessarily involve the plants which manufacture the pesticides and some useful insights might be gained by an approach which took the manufacturing sites into consideration as well as the pesticides themselves.

This approach showed that some of the plants which manufacture high priority pesticides also manufacture pesticides with lower priorities. If the source assessment of a particular pesticide involved assessing plants which also produce other major pesticides, it may be useful to know that this was the case. In fact, we assumed that this condition was desirable in this selection method, and chose pesticides for detailed assessment which were manufactured at the same plant(s) to allow greater flexibility in the source assessment procedure, and, at the same time, retained the high priority pesticides in the select list. The select list in this case is not limited to six pesticides.

Table 15 shows the pesticides with the highest priority ratings and the plants which manufacture them. The table also includes several pesticides with lower priority ratings that are manufactured by the same plant(s) which produce the high priority rating pesticides listed. Several points regarding Table 15 require further explanation to show why some pesticides are excluded, while others are included.

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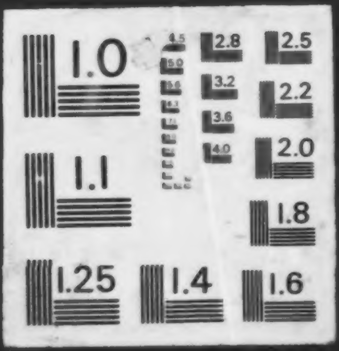
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1.25
1.4
1.6

Table 14. PRIORITY RANKING OF INDIVIDUAL SYNTHETIC ORGANIC PESTICIDES FOR DETAILED SOURCE ASSESSMENT, BY CHEMICAL GROUP

	Numerical rating						
Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	Total priority rating
Group A							
DDT	4	2	4	3	4	4	21
PCP and sodium salts	4	3	4	1	3	0	15
Toxaphene	4	2	0	2	2	2	12
Lindane and BHC	1	2	0	1	4	4	12
Trichlorophenols	4	1	4	0	2	0	11
Silvex	1	1	4	0	1	0	7
2,4-D, acids, esters, salts	4	2	0	0	0	0	6
Methoxychlor	1	1	0	1	1	2	6
Dichloropropene	3	2	0	0	0	0	5
Chloramben	3	1	0	0	1	0	5
DBCP	3	2	0	0	0	0	5
Sodium TCA	3	1	0	0	1	0	5
Dicofol	1	1	0	0	2	1	5
DCPA	1	1	0	0	2	0	4
2,3,6-TBA	1	1	0	0	2	0	4
Dalapon	1	1	0	0	1	0	3
Endothall	1	2	0	0	0	0	3
Dicamba	1	1	0	0	1	0	3
Group B							
Parathion	3	4	0	4	0	1	12
Methyl parathion	4	4	0	3	0	1	12
Phorate	3	4	0	3	1	0	11
Diazinon	3	2	0	3	1	1	10
Disulfoton	3	3	0	3	1	0	10

Table 14. (Continued)

	Numerical rating						
Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation biomagnification, and mobility	Total priority rating
Group B (continued)							
Fensulfothion	2	4	0	3	1	0	10
Dyfonate®	1	4	0	3	1	0	9
Monocrotophos	2	3	0	3	0	0	8
Malathion	4	1	0	1	0	1	7
Merphos	1	2	4	0	0	0	7
Carbofenthion	1	3	0	3	0	0	7
Ronnel	1	1	4	1	0	0	7
Dimethoate	1	2	4	0	0	0	7
DDVP	1	2	0	3	0	0	6
Guthion®	1	3	0	1	1	0	6
Ethion	1	3	0	0	0	0	4
Naled	1	2	0	1	0	0	4
DEF®	1	2	0	0	0	0	3
Group C							
Carbaryl	4	2	4	0	0	1	11
Carbofuran	3	3	0	3	0	1	10
Maneb	3	1	4	0	1	0	9
Methomyl	3	3	0	3	0	0	9
Aldicarb	1	4	0	4	0	0	9
Zineb	2	1	4	0	0	0	7
Nabam	1	2	4	0	0	0	7
Bux®	3	2	0	0	0	0	5
Polyram	1	0	4	0	0	0	5
Butylate	2	1	0	0	1	0	4
EPTC	2	1	0	0	1	0	4
Vernolate	1	1	0	0	1	0	3
Benomyl	1	0	0	1	0	0	2

Table 14. (Continued)

Pesticide	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation, biomagnification, and mobility	Total priority rating
	Numerical rating						
Group D							
Atrazine	4	1	0	0	2	1	8
Simazine	3	1	0	0	3	1	8
Propazine	3	0	0	0	4	0	7
Group E							
Alachlor	4	1	0	0	1	0	6
Propachlor	4	1	0	0	0	0	5
Propanil	3	1	0	0	0	1	5
Butachlor	3	1	0	0	0	0	4
Group F							
MSMA	4	3	4	0	3	2	16
DSMA	3	1	4	0	3	2	13
Cacodylic acid	1	1	4	0	3	1	10
Copper naphthenates	1	1	0	0	1	0	3
Group G							
Captan	3	2	4	0	0	0	9
Maleic hydrazide	2	1	4	0	0	0	7
Picloram	1	1	0	0	4	0	6
Captafol	1	1	4	0	0	0	6
Nitralin	1	1	0	3	1	0	6
Folpet	1	0	4	0	0	0	5
CDAA	2	1	0	0	1	0	4

Table 14. (Concluded)

Pesticide	Numerical rating						Total priority rating
	Total 1974 production	Acute mammalian toxicity	Special toxicity	Wildlife toxicity	Persistence	Bioaccumulation, biomagnification, and mobility	
Group H							
Chlordane	3	2	4	1	4	4	18
Heptachlor	1	3	4	1	4	4	17
Aldrin	3	3	0	2	4	4	16
Endrin	1	4	0	3	3	4	15
Endosulfan	1	3	0	1	2	1	8
Group I							
Monuron	1	1	4	0	2	0	8
Diuron	3	2	0	0	2	0	7
Bromacil	3	1	0	0	2	0	6
Fluometron	1	2	0	0	2	0	5
Linuron	1	1	0	0	2	0	4
Terbacil	1	0	0	0	2	0	3
Group J							
Dinoseb	1	3	4	3	1	0	12
Trifluralin	4	2	0	3	1	0	10
Chloropicrin	1	2	0	1	1	0	5
Benefin	1	1	0	0	2	0	4

Table 15. PRIORITY RANKING OF SYNTHETIC ORGANIC PESTICIDES FOR DETAILED SOURCE ASSESSMENT BY CHEMICAL GROUP AND MANUFACTURER

Group	Pesticide	Priority rating	Manufacturer(s)[a]
A	DDT	21	Montrose, Torrance, CA
	PCP and sodium salts	15	Monsanto, Sauget, IL Vulcan, Wichita, KS Dow, Midland, MI Dover, Dover, OH Reichhold, Tacoma, WA
	Toxaphene	12	Hercules, Brunswick, GA Vicksburg, Vicksburg, MS Tenneco, Fords, NJ Riverside, Groves, TX
B	Parathion	12	Monsanto, Anniston, AL Stauffer, Mt. Pleasant, TN
	Methyl parathion	12	Monsanto, Anniston, AL Stauffer, Mt. Pleasant, TN Kerr-McGee, Hamilton, MS
	Phorate	11	American Cyanamid, Linden, NJ
	Disulfoton	10	Chemagro, Kansas City, MO
	Fensulfothion	10	Chemagro, Kansas City, MO
C	Carbaryl	11	Union Carbide, Institute and South Charleston, WV
	Carbofuran	10	FMC, Middleport, NY FMC, Vancouver, WA
	Aldicarb	9	Union Carbide, Institute and South Charleston, WV
D	Atrazine	8	Ciba-Geigy, St. Gabriel, LA
	Simazine	8	
	Propazine	7	
E	Alachlor	6	Monsanto, Muscatine, IA
	Propachlor	5	
	Butachlor	4	

Table 15. (Concluded)

Group	Pesticide	Priority rating	Manufacturer(s)[a]
F	MSMA	16	Vineland, Vineland, NJ Diamond Shamrock, Greens Bayou, TX Ansul, Marinette, WI
	DSMA	13	W. A. Cleary, Somerset, NJ Vineland, Vineland, NJ Diamond Shamrock, Greens Bayou, TX Ansul, Marinette, WI
	Cacodylic acid	10	Vineland, Vineland, NJ Ansul, Marinette, WI
G	Captan	9	R.T. Vanderbilt, Bethel, CT Chevron, Perry, OH Stauffer, Perry, OH
	Maleic hydrazide	7	Uniroyal, Geismar, LA Fairmount, Newark, NJ Ansul, Marinette, WI Chemical Formulators, Nitro, WV
	Folpet	5	Chevron, Perry, OH Stauffer, Perry, OH
	CDAA	4	Monsanto, Muscatine, IA
H	Chlordane	18	Northwest Industries, Marshall, IL Prentiss Drug, Newark, NJ
	Heptachlor	17	Northwest Industries, Memphis, TN
	Endrin	15	
I	Monuron	8	Du Pont, La Porte, TX
	Diuron	7	
	Bromacil	6	
	Terbacil	3	
J	Dinoseb	12	Dow, Midland, MI Vicksburg, Vicksburg, MS Blue Spruce, Edison, NJ
	Trifluralin	10	Eli Lilly, Lafayette, IN
	Benefin	4	

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[a] Source: SRI (1976). (Ref. 10)

In Group A, DDT and PCP (and sodium salts) were selected due to their high priority rating. Toxaphene was chosen over lindane and BHC (rating of 12, also) since toxaphene is produced in a far larger annual volume than lindane and BHC (about 110 million pounds versus about 4 million pounds) and toxaphene is the subject of increasing regulatory and environmental concern.

In Group B, all of the pesticides shown in the table were selected on the basis of a high priority rating. Diazinon, with a rating of 10, was excluded since two plants manufacture this pesticide, and both fensulfothion and disulfoton, with ratings of 10, are manufactured by the same single plant.

In Group C, aldicarb was chosen over maneb and methomyl, since each is produced at three plants and two plants, respectively, whereas aldicarb is produced at only one plant, and that plant is the sole producer of carbaryl, also.

The selections in Groups D, E, and F are obvious, and the selection of captan and maleic hydrazide in Group G are based on the high priority ratings. In Group G, folpet was added since it is produced at the same plants as is captan, and CDAA was added since it is produced at the same plant which produces the anilides in Group E.

The selections in Group H and I are obvious except for the fact that aldrin (rating of 16) was excluded in Group H. Aldrin is no longer being manufactured by Shell Chemical Company in Denver, Colorado, who was the sole producer of this pesticide in 1974.

In Group J, dinoseb and trifluralin were selected on the basis of high priority ratings and benefin was added since it is manufactured by the same plant which manufactures trifluralin.

The pesticides listed in Table 15 were reduced to a smaller number by making one further assumption; namely that it would be more economical and efficient to assess pesticides produced at the same plant(s) and those pesticides produced at the fewest plants, when the priority ratings were the same or nearly the same for alternate pesticides. This assumption led to the final select list of pesticides shown in Table 16. The 27 major pesticides in that table represent the highest priority pesticides in each chemical group except chlordane (Group H) and dinoseb (Group J). Detailed source assessments of 27 major pesticides could be made by visiting 18 plant sites. The listing of 27 candidate pesticides can be reduced to six by comparison with the pesticide selections from the other two alternate methods.

SUMMARY AND INTERCOMPARISON OF PESTICIDE SELECTIONS BY THE THREE ALTERNATE METHODS

As indicated in Table 9 (p. 69) the total number of pesticide candidates selected by the three alternate methods are:

Table 16. CANDIDATE PESTICIDES SELECTED BY PRIORITY AND MANUFACTURER

Chemical group	Pesticide	Manufacturer
A	DDT	Montrose, Torrance, CA
B	Parathion and methyl parathion	Monsanto, Anniston, AL Stauffer, Mt. Pleasant, TN Kerr-McGee, Hamilton, MS
	Disulfoton and fensulfothion	Chemagro, Kansas City, MO
C	Carbaryl and aldicarb	Union Carbide, Institute and South Charleston, WV
D	Atrazine, simazine, and propazine	Ciba-Geigy, St. Gabriel, LA
E	Alachlor, propachlor, and butachlor	Monsanto, Muscatine, IA
F	MSMA, DSMA, and cacodylic acid	Vineland, Vineland, NJ Ansul, Marinette, WI Diamond Shamrock, Greens Bayou, TX W. A. Cleary, Somerset, NJ
G	Captan and folpet	Chevron, Perry, OH Stauffer, Perry, OH R. T. Vanderbilt, Bethel, CT
	CDAA	Monsanto, Muscatine, IA
H	Heptachlor and endrin	Northwest Industries, Memphis, TN
I	Monuron, diuron, bromacil, and terbacil	Du Pont, La Porte, TX
J	Trifluralin and benefin	Eli Lilly, Layfayette, IN

Method No. 1	6
Method No. 2	10
Method No. 3	27

The problem before us is to select six final candidate pesticides for detailed source assessment utilizing as much as possible the advantages of all three methodologies. Method No. 1 rank-orders the pesticides by a total priority rating system ignoring other considerations such as chemical class, manufacturer, location, and other pesticides jointly manufactured. Methods Nos. 2 and 3 take these factors into consideration as was previously developed. The authors believe each methodology has merit, that none is "perfect," and that none is unique among other possible methodologies. Indeed, there may be another set of methodologies possible to perform the selection, e.g., one based on a "weighted" priority rating system using the same criteria (production volume, toxicity, etc.) but individually weighted differently.

Utilizing the results from the three methodologies the final selection of six pesticide candidates for detailed source assessment is made as follows:

- Select common pesticide candidates from the three lists.
- Select candidates from as many different chemical classes as possible (maximum of six).
- Select candidates having higher priority ratings as opposed to those of lower priority ratings.

These guidelines suggest the final six pesticide candidates for the following reasons:

DDT and MSMA - common to all three methodologies, two different chemical classes, high priority ratings.

Parathion (or methyl parathion which is numerically equivalent), carbaryl, and chlordane (or heptachlor or endrin which are numerically equivalent) - common to two methodologies, three different chemical classes, high priority ratings.

PCP (and salts) - high priority rating.

Thus, six final candidate pesticides have been selected encompassing five chemical classes, individually having high total priority ratings (ratings of 21 to 11) and having indicated the manufacturer and the geographic location. The report also indicates which alternate pesticides are manufactured at these locations for possible assessment in addition to the final selected candidate pesticide.

The basic data in this section are developed in a manner to allow reassessment of any pesticide relative to other pesticides if an alternate methodology is preferred.

REFERENCES TO SECTION 4

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SECTION 5

PRESENT AND ANTICIPATED REGULATORY CLIMATE FACING PESTICIDE MANUFACTURERS

INTRODUCTION

The pesticide manufacturing industry will continue to face direct regulation from EPA and the Occupational Safety and Health Administration (OSHA), the two independent agencies having the greatest interest in pesticide manufacturing activities. EPA will continue to have major responsibility for enforcement of pollution standards (air, water, and solid waste) and registration of pesticides. OSHA will continue its concern with worker health and safety. In addition, some indirect regulation may come from the Consumer Product Safety Commission (CPSC), but it is not considered to have a major impact on pesticides at this time.

GOVERNMENT GROUPS AT INTEREST

A complete listing of governmental groups at interest in pesticide manufacturing is unavailable at this time. A partial listing of federal groups and individuals is shown in Table 17. Most of the discussion of anticipated regulation was conducted with these individuals. They represent the range of government agencies and groups interested in pesticide manufacture and registration. While they cannot be construed as spokesmen for their respective groups, these are the appropriate individuals for further discussion of the regulatory pressures facing pesticide manufacturers.

EXECUTIVE AGENCIES

Two cabinet-level agencies, the Department of Agriculture and the Department of Commerce, have the major responsibility for pesticide manufacture and use. They, in conjunction with the Office of Management and Budget (OMB), serve as a counterbalance to the interests of other executive agencies concerned with pesticides. Traditionally, they represent farmers and business, respectively. As noted earlier, EPA and OSHA are concerned with the regulation of the production and environmental use of pesticides.

Table 17. INDIVIDUALS CONTACTED TO DISCUSS ANTICIPATED REGULATORY PRESSURES FACING PESTICIDE MANUFACTURERS

EPA	
Mr. Fred Talcott	Office of Pesticide Programs
Mr. Jeff Jones	Operations Division
Mr. William Wymer	Federal Working Group on Pest Management
Mr. Bob Wahlen	Congressional Liaison Office
Senate	
Mr. Bill Taggert	Committee on Agriculture and Forestry
Mr. Mike Brownlee	Committee on Commerce Subcommittee on the Environment
Mr. Steve Quarles	Committee on Interior and Insular Affairs Subcommittee on Environment and Land Resources
Mr. Richard Hellman	Committee on Public Works Subcommittee on Environmental Pollution
House	
Mr. Nick Ashmore	Committee on Agriculture
Ms. Sue Nelson	Committee on Education and Labor Subcommittee on Manpower, Compensation, and Health Safety
Mr. Dave Nix	Committee on Interior and Insular Affairs Subcommittee on Energy and Environment
Mr. Rod Byerly	Committee on Science and Technology
Mr. Lynch	Committee on Small Business Subcommittee on Regulatory Agencies
OSHA	
Mr. Phil Beck	
CEQ	
Dr. Warren Muir	
OMB	
Mr. Tozzi	
Library of Congress	
Dr. John Blodgett	Environmental Policy Research Division

LEGISLATIVE AGENCIES

The Senate has four committees with interest (although not necessarily jurisdiction) in pesticides manufacturing and use--Agriculture and Forestry, Commerce, Interior and Insular Affairs, and Public Works. Of the four, only Interior and Insular Affairs feels it does not have jurisdiction.

The House of Representatives has five committees with interest in pesticides manufacturing and use--Agriculture and Forestry, Education and Labor, Interior and Insular Affairs, Science and Technology, and Small Business. Once again, Interior and Insular Affairs claims no jurisdiction. Small Business and Science and Technology have not focused a great deal of their attention on pesticide matters.

The Library of Congress, through the Congressional Research Services, provides information services and data analyses to congressional committees. The Environmental Policy Research Division is responsible for analytical research work in the area of pesticides.

AREAS OF REGULATORY INTEREST

Existing Regulations

According to all sources, there will be little or no change in existing regulations. All existing standards, tolerances, and exposure limits will continue in force. Most important, whatever changes do occur, they will not result in a loosening of existing regulations.

Anticipated Regulations

Eighteen areas of anticipated regulatory interest were suggested. These areas were grouped into eight major categories on the basis of the major concern, e.g., testing, exposures, etc., and are shown in Table 18 and discussed below.

Table 18. MAJOR ANTICIPATED AREAS OF REGULATORY INTEREST

1. Testing
2. Inspection
3. Exposure
4. Disposal
5. Insurance/Indemnity
6. Control Technology for Biological Pesticides
7. Economic Impact Statement
8. Public Pressure

Testing--

Two additional testing requirements are anticipated. The first is large-scale long-term testing for the effects of low level exposure. The second is a requirement for some testing to be done by independent laboratories. The emphasis in all testing will be on mutagenic and teratogenic effects.

Inspection--

It is anticipated that both EPA and OSHA will conduct on-site inspections to determine if pollution levels (EPA) and exposure levels (OSHA) are within the established limits.

Exposure--

There appear to be two concerns here. The first is preventive; the second relates to already exposed workers. The preventive concern is to establish procedures, devise clothing, etc., that will safeguard those workers involved in formulating chemical or biological pesticides. The second concern seeks to assist those workers who have been exposed to excessive levels of harmful materials with adequate medical attention and follow-up.

Waste Disposal--

The current procedures for waste disposal may prove harmful or inadequate. Other methods of waste disposal may be required, especially in the solid waste area.

Insurance/Indemnity--

A number of suggestions have been offered to create an insurance/indemnity program to protect the worker and the company. In some cases an argument is made to increase company liability in workman's compensation. Others argue for some other risk-sharing arrangement, e.g., an indemnity tax on purchase price.

Control Technology for Biological Pesticides--

Despite the benefits of biological control of pest infestation, the costs of preventing their unrestricted release to the atmosphere and land may be prohibitive. Without adequate control mechanisms, severe restrictions on the use of biological pesticides may exist.

Economic Impact Statement--

The need for a given chemical pesticide may outweigh its potential danger. This usually is determined by an economic impact statement. Consequently, despite some risk, a given chemical pesticide may continue to be manufactured and used.

Public Pressure--

This is virtually an unknown factor affecting all pesticide manufacturers. Public pressure on officials and the government can cause arbitrary and capricious decisions to be hastily made. There is little time to anticipate what practice, if any, will cause a public outcry. Hence, manufacturers (and EPA) will have little "a priori" opportunity to anticipate this regulatory pressure.

APPENDIX A

INDUSTRIAL CHEMICALS ALSO USEFUL AS PESTICIDES

Pesticides, General Listing	Caswell Accession No.	Pesticide Type
Acrolein	9	H
Acrylonitrile	10	Fu
Allyl Alcohol	26	H
Ammonium Thiocyanate	--	H
Anthraquinone	52A	R
Arsenic Acid	56	H
Biphenyl	87	F
Bis(diethylthiocarbamoyl)disulfide	--	F
Bis(dimethylthiocarbamoyl)disulfide	--	F,R
Bis(dimethylthiocarbamoyl)sulfide	--	F
Borascu Borax Boro-Spray Sodium Borates	108	H,I
Calcium Arsenate	137	I
Carbon Disulfide	162	Fu
Carbon Tetrachloride	164	Fu
Copper Acetoarsenite (Paris Green)	638	I
Copper Carbonate	235	F
Copper Naphthenate	245	F
Copper Oleate	248	F
Copper Oxychloride Sulfate	250	F
Copper Sulfate	256	F
DHA (dehydroacetic acid)	278	F
DMP (dimethyl phthalate)	380	R
Dichlorobenzene (ortho and para isomers)	623, 632	I
Dimethyldithiocarbamic acid, K salt	--	F
Dimethyldithiocarbamic acid, Na salt	--	F
Dimethyldithiocarbamic acid, Zn salt	--	F,R
Diphenylamine	398	I
Ethylene	436	PGR
Ethylene Dibromide	439	I,N
Ethylene Dichloride	440	Fu
Ethylene Oxide	443	Fu
Ethyl Formate	443A	Fu
Formaldehyde, formalin	465	Fu
HCB (hexachlorobenzene)	477	F
HCN (hydrocyanic acid)	483	Fu

Pesticides, General Listing	Caswell Accession No.	Pesticide Type
Lead Arsenate	524	I
Mercuric Chloride	544	F
OPP (o-phenylphenol)	658	F
Sodium Arsenite	744	H,I
Sodium Chlorate	753	H
Sodium Fluoride	769	R
Sulfur	812	F,M
Thiram	856	F,R

Total 46 Compounds

Source: Stanford Directory of Chemical Producers - USA, Stanford Research Institute, Meno Park, California, 1976.

APPENDIX B

SUMMARY UPDATE TO THE POLLUTION POTENTIAL IN PESTICIDE MANUFACTURING - 1972

The use of pesticides has become an extremely important factor in the United States and indeed throughout the world in determining man's quality of life. The benefits which have been obtained from this usage--increased production of food and fiber and increased freedom from disease and obnoxious plant and animal life--have not been without some undesirable side effects, such as direct effects on nontarget organisms, the indirect unbalancing of delicate ecosystems, and the environmental contamination by persistent pesticides which may tend to be biologically accumulated in food chains. In addition, the possible long-term effects of low levels of pesticides on man himself are the cause of serious concern. Hence, the entire subject of pesticide production and use is under intensive study by government and nongovernment scientists in the United States and in many other countries.

The production and use of pesticides is not new or even of recent origin. From ancient times man has investigated the minerals, and the plant and animal life around him for their value as medicinals, in the production of his food, in warding off the attacks of obnoxious or dangerous insects, and against his fellow man. A tremendous growth has occurred, however, during the past 40 years in the number of pesticides available, the variety of applications, and the volumes of production of the active ingredients and their formulated products. A broad definition of "pesticides" is used here which includes: rodenticides, insecticides, larvacides, miticides (acaricides), molluscicides, nematocides, repellants, synergists, fumigants, soil conditioners, fungicides, algicides, herbicides, defoliants, desiccants, plant growth regulators, and sterilants.

EPA's Office of Pesticide Programs (OPP) has estimated that in 1975 there were 1,200 pesticide active ingredients registered for use in pesticide products. This estimate is based on the assumption that some active ingredients have multiple uses, so that the 1,200 estimate counts each active ingredient only once.

These active ingredients are formulated into 23,633 different pesticide products (as of October 23, 1975) at 5,353 registered formulating plants (as of July 9, 1975) throughout the United States. These plants are registered as follows: 4,111, interstate; 1,023, intrastate; and 218, foreign.

The objective of this study was to survey and evaluate the environmental pollution potential associated with the manufacture, formulation, and marketing of pesticides, including such related activities as packaging, transportation, and warehousing, i.e., all of the operations up to the point at which a pesticide is placed in the hands of the consumer.

PESTICIDE PRODUCTION VOLUMES

In order to evaluate the pollution potential of pesticide manufacture, knowledge of current production volumes was needed. A serious handicap here was the unavailability of data on how much of each pesticide is produced or even on which ones are produced in the largest quantities in the United States. Most of this information is in the hands of the U.S. International Trade Commission, but it is not disclosed in a useful manner. The International Trade Commission publishes partial production data for synthetic organic compounds. A section on pesticides is included, but the data are categorized and grouped; no data are disclosed for specific compounds unless there are three or more producers (and not even then if one producer is dominant) because these data are considered proprietary by the companies and are revealed in confidence to the Commission. Under this policy, production data are not now available on the most widely used insecticide (toxaphene) or herbicide (atrazine). We strongly recommend that public disclosure of production data for pesticides and all hazardous materials be made mandatory, so that scientists, regulatory officials, legislators, and other concerned citizens can make use of these data for an intelligent assessment of environmental impacts and of areas which require further research, new regulations or legislation. Furthermore, a sizable percentage of the pesticide industry may be in favor of the uniform disclosure of these data because under the present situation most companies must maintain an expensive staff of market researchers to develop many of these data anyway.

The 1974 production volumes of all synthetic organic pesticides have been estimated on this program. The results for the major synthetic organic pesticide groups and individual pesticides are shown in Tables B-1 to B-3 and show that the 1.42 billion pounds of active pesticide ingredients produced in 1974 consisted of about 37 major pesticides (those produced in volumes of 10 million pounds or more). This accounted for a combined production of 1.04 billion pounds or 74% of the market while the remaining 26% is divided among 300 other pesticides. A total of 140 to 150 synthetic organic pesticides are estimated to have had production volumes in excess of 1 million pounds in 1974.

STUDY APPROACH

The approach used in this survey and evaluation has been to select pesticides, producers, formulators, and packagers which would be representative of the industry.

A system was developed in which pesticides were rated on the basis of production volume (present and projected), chemical class and production technology, use pattern (biological activity and major crops), toxicity including human (acute and public health) and nontarget, persistence and biomagnification, and public or legislative concern.

Table B-1. U.S. PRODUCTION OF SYNTHETIC ORGANIC PESTICIDES, BY CATEGORY, IN 1974

PESTICIDE CATEGORIES	1974 Production (Millions of pounds)
Fungicides	
PCP and sodium salts	52.4
Naphthenic acid, copper salt	2.0
Other cyclic fungicides	70.1
Dithiocarbamic acid salts	35.4
Other acyclic fungicides	2.8
Total fungicides	162.7
Herbicides and plant hormones	
Maleic hydrazide	5.8
2,4-D acid, dimethylamine salt	14.5
Other cyclic compounds	467.4
All acyclic compounds	116.5
Total herbicides and plant hormones	604.2
Insecticides, rodenticides, soil conditioners and fumigants	
Aldrin-toxaphene group	141.7
Methyl parathion	51.4
Other cyclic organophosphorus insecticides	56.4
Methoxychlor	3.2
Other cyclic insecticides and rodenticides	160.5
Methyl bromide	30.5
Acyclic organophosphorus insecticides	78.8
Chloropicrin	4.8
Other acyclic insecticides, rodenticides, soil conditioners, and fumigants	123.0
Total	650.3
Total synthetic organic pesticide production, 1974	1,417.2

Source: U.S. International Trade Commission (1975).

Table B-2. U.S. PRODUCTION OF SYNTHETIC ORGANIC PESTICIDES, BY CHEMICAL GROUP, IN 1974

Chemical group	Estimated 1974 production (Millions of pounds)	Estimated percentage of total production (Rounded)
lorinated hydrocarbons	460	33
ganophosphorus	200	14
rbamates	150	10
iazines	150	10
ilides	110	8
her nitrogenous compounds	70	5
ganoarsenicals and organometallics	55	4
ene-based	40	3
eas and uracils	40	3
trated hydrocarbons	40	3
l others	102	7
Total	1,417	100

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urce: MRI estimates (February 1976)

Table B-3. ESTIMATED U.S. PRODUCTION OF MAJOR INDIVIDUAL SYNTHETIC ORGANIC PESTICIDES, BY CATEGORY, IN 1974

Chemical group	Pesticide	Estimated 1974 production (Millions of pounds)	Approximate percentage of production in each group
Chlorinated hydrocarbons	Toxaphene	110	24
	DDT	60[a]	13
	2,4-D acid, esters, salts	55[b]	12
	PCP and sodium salts	52[c]	11
	Trichlorophenols	25	6
	Dichloropropene	25	6
	Chloramben	22	5
	DBCP	20	4
	Sodium TCA	15	3
	All others	76	16
		460	100
Organophosphates	Methyl parathion	51[c]	25
	Malathion	30	15
	Parathion	17	9
	Diazinon	12	6
	Disulfoton	10	5
	Phorate	10	5
	Monocrotophos	7	4
	Fensulfothion	6	3
	Merphos	5	2
	All others	52	26
		200	100
Carbamates	Carbaryl	58	39
	Maneb	12	8
	Metalkamate (Bux®)	10	7
	Carbofuran	10	7
	Butylate	8	5
	Zineb	7	5
	EPTC	6	4
	Nabam	5	3
	Vernolate	5	3
	Aldicarb	5	3
	All others	24	16
		150	100
Triazines	Atrazine	110	73
	Simazine	15	10
	Propazine	10	7
	All others	15	10
		150	100
Anilides	Propachlor	45	41
	Alachlor	40	36
	Propanil	15	14
	Butachlor	10	9
		110	100
Organoarsenicals and organometallics	MSMA	35	64
	DSMA	10	18
	Cacodylic acid	3	5
	Copper naphthenates	2[c]	3
	All others	5	10
		55	100

Table B-3. (Concluded)

Chemical group	Pesticide	Estimated 1974 production (Millions of pounds)	Approximate percentage of production in each group
Other nitrogenous compounds	Captan	20	29
	Methomyl	10	14
	CDAA	7	10
	Maleic hydrazide	6[c]	9
	Benomyl	4	6
	Nitralin	3	4
	Picloram	3	4
	Captafol	3	4
	Folpet	3	4
	All others	11	16
		70	100
iene-based	Chlordane	15[d]	38
	Aldrin	10[e]	25
	Endrin	3	7
	Heptachlor	3[d]	7
	Endosulfan	3	7
	All others	6	16
		40	100
reas and uracils	Bromacil	12	30
	Diuron	10	25
	Fluometuron	5	13
	Linuron	3	7
	Terbacil	3	7
	All others	7	18
		40	100
trated hydrocarbons	Trifluralin	25	63
	Chloropicrin	5[c]	13
	Dinoseb	3	7
	Benefin	3	7
	All others	4	10
		40	100
l others	Methyl bromide	31[c]	30
	Miscellaneous	71	70
		102	100
Total all synthetic organic pesticides		1,417[c]	

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urce: MRI estimates (February 1976)

Based upon DDT exports of 56.4 million pounds (100% basis) in 1974, as reported in The Pesticide Review, 1974 (1975).

Based upon report in Chemical Marketing Reporter, January 5, 1976.

Based upon data published by U.S. Internation Trade Commission (1975).

Based upon report in Chemical Marketing Reporter (July 14, 1975).

Based upon report in Chemical Marketing Reporter (April 14, 1975).

On the basis of these ratings, 22 representative pesticides were selected for intensive study of the pollutional aspects of the manufacturing process. These 22 pesticides are listed in Table B-4 along with their use, chemical class, estimated production, mammalian toxicity and relative environmental persistence. The production sites of these pesticides are shown in Figure B-1.

Personal contacts and visits were made with the producers of the 22 selected pesticides and also with 15 formulators and packagers and these were supplemented by review of the literature on production, formulation, packaging, and marketing practices.

SPECIAL NOTES FROM THE CASE STUDIES OF MANUFACTURERS

The case studies developed a considerable amount of information on the practices of the pesticide manufacturers which is related to the overall pollution potential. Because of the diversity of processes used for the different pesticides and the different pollution control practices employed, comparison is difficult, but several aspects are worthy of discussion.

Raw Materials

The raw materials used for the synthesis of many pesticides are hazardous materials, and some pollution potential is inherent in the transportation and handling of materials of this nature. Some of these materials are flammable, some are corrosive and poisonous, and some may be exceptionally toxic to fish if spilled into waters. However, the transportation of these materials is subject to close governmental regulation, and the handling practices of the pesticide manufacturers are as good as or better than those of industry in general.

The raw material which is common to the most pesticides is elemental chlorine, which is used directly on-site in the production of chlordane, toxaphene, 2,4-D, 2,4,5-T, atrazine, captan, carbaryl, and mercuric chloride and is used to prepare raw materials brought in for the production of DDT, aldrin-dieldrin, and perhaps also trifluralin and alachlor. The production of this chlorine formerly involved extensive use of the mercury cells which led to the well publicized mercury losses. Now, however, these cells are being better controlled and are being displaced by the mercury free diaphragm cells. Only two of the pesticide producers studied here use on-site chlorine generation, while the other chlorine users receive it in tank car quantities by rail, with the exception of one plant which receives it by pipeline.

Other materials of unusually hazardous nature which are transported by rail, barge or truck include hydrogen cyanide (of which over 10 million pounds are required for atrazine), carbon disulfide, various amines, and the concentrated acids and caustic. The P_2S_5 used in all the organophosphorus pesticides, Table B-4. USES, CLASSES AND PRODUCTION VOLUMES OF SELECTED PESTICIDES

Selected Pesticides	Fungicides	Fumigants	Herbicides	Insecticides	Chlorinated hydrocarbons	Triazines	Carbamates, N-alkyl	Aryl organophosphates	Aliphatic organophosphates	Inorganics	Botanicals	Biologicals	Other	Estimated annual production 1974 (MM lb/year)	Oral mammalian toxicity LD_{50} (mg/kg)	Environmental persistence
Alachlor (Lasso)			H										X	40	1,200	Low
Aldicarb (Temik)				I			X							5	0.6	Low
Aldrin				I	X									10	40	High
Atrazine			H			X								110	1,750	Low
B. thuringiensis				I								X		2	Nontoxic	Low
Captan	F												X	20	480	Medium
Carbaryl (Sevin)				I			X							58	89	Low
Chlordane				I	X									15	283	High
2,4-D			H		X									55	375	Low
DDT				I	X									60	113	High
Dieldrin				I	X									0.5	46	High
Disulfoton				I					X					10	10	Low
Malathion				I					X					30	600	Low
Mercury fungicides	F									X				0.2	30-200	Low
Methyl bromide		Fu											X	31	21 mg/ℓ	Low
Methyl parathion				I				X						51	4	Low
Parathion				I				X						17	2	Medium
Phorate (Thimet)				I					X					10	1	Medium
Pyrethrins				I							X			0.3	1,500	Low
2,4,5-T			H		X									5	300	Low
Toxaphene (including Strobane-T)				I	X									110	60	Medium
Trifluralin (Treflan)			H										X	25	500	Low
Totals (22 pesticides)	2	1	5	14	7	1	2	2	3	1	1	1	4	665.0		

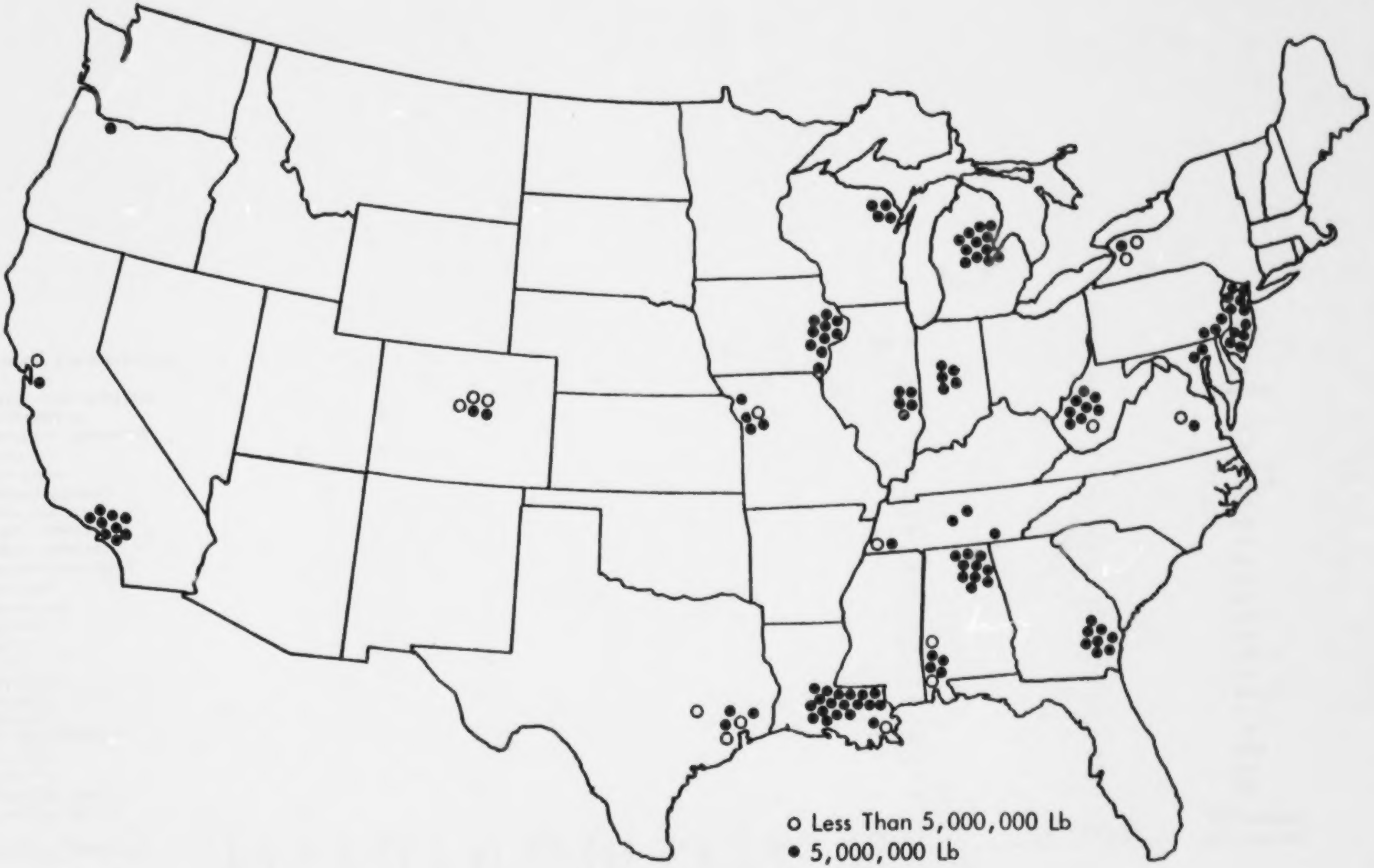
○ Less Than 5,000,000 Lb
● 5,000,000 Lb

Figure B-1. Production distribution for 22 major pesticides the C_5Cl_6 used for aldrin, and numerous other materials also pose some hazard.

The raw materials may be stored on-site in bulk storage facilities, but in many cases are drawn directly from the shipping container (e.g., tank car or tote bin) and used in the production processes. The handling of materials such as chlorine are apparently in conformity with good industrial practice codes. Accidental spills of raw materials occasionally occur which require special clean-up and disposal procedures. In many cases, scrubbers or dust collection equipment are used in the raw material unloading areas.

Production Processes

The manufacturing processes for pesticides vary considerably from product to product, but two characteristics are generally present which may differentiate the pesticide industry from many, if not all, of the large industries which are of environmental pollution concern: (a) the ingredients handled or produced can have high toxicity to some animals (e.g., man or fish) or plant life; and (b) the production processes normally require only low or moderate temperatures, compared for example to industries producing ore- or rock-derived products. Because of the toxicity of the materials handled, production facilities were designed to include a great many safety features to minimize occupational hazards. Because of the moderate temperature, air pollution control of good efficiency could be largely adapted from existing technology. Water pollution control, as discussed in a subsequent section, poses a much more difficult problem than air pollution in the pesticide industry.

The production plants for the 22 key pesticides studied range from capacities of less than 1 million pounds per year to about 100 million pounds per year, and the plant equipment ranges from 1 year old to over 20 years old, and in at least two cases the plant buildings are over 50 years old. In general, the more toxic materials such as the organophosphorus and carbamate insecticides and some of the herbicides which have undergone rapid growth recently (such as atrazine) are produced in new plants, while many of the older chlorinated hydrocarbons and other products are produced in somewhat older equipment. However, almost none of the plants have been designed since the advent of the recent increased consciousness of environmental concern, and most of the companies interviewed have recently completed, are building, or are designing new pollution control equipment to bring their plants into conformity with local standards.

The production equipment is used in almost every case, either for only one product or for two very similar products, i.e., two products of the same chemical family and with similar pesticidal applications. Cleanup of equipment is therefore minimal, especially when compared to that required in a formulation plant where many products are processed through the same equipment. In cases in which solvent cleanup of process equipment is required, the used solvent is generally reused as a matter of economics by recycling to the process, or it may be used in formulation or combusted for fuel.

Most of the companies interviewed have fairly extensive contingency plans. Many of them maintain a company fire department; and others state that they work closely with local fire departments, but this cooperation could probably be improved in nearly all cases.

Good practice dictates that production facilities be diked and that runoff from malfunction, spills, fire extinguishment, etc., be contained in a holding pond or pit until treated, so that overloading of the conventional waste treatment plant is avoided. This procedure is in effect in many plants.

All the manufacturers of the 22 key pesticides have on-site quality control laboratory facilities and frequently monitor the raw materials and reaction intermediates as well as the final product. In almost no case, it would seem, is a production run of such poor quality or so far "off spec" that it cannot be used--either blended off with a higher quality batch or reworked to remove objectionable impurities.

The efficiency of the synthesis reactions as commercially conducted is generally regarded as proprietary information. Similarly, the efficiencies of recovery of products, by-products, and unreacted starting materials are not available. The efficiency of recovery in the past has often depended on the price of the product balanced against the difficulty of recovery, and hence a widely and easily produced material like DDT was previously discharged in sizable quantities. The present trend is toward better recovery and water economy in order to minimize treatment or disposal costs.

Storage, Handling, and Shipping

The use of most pesticidal products is seasonal with the major application occurring during the spring or summer season. Therefore, production and formulation also tend to be seasonal in order to avoid building up undesirably large inventories. Among the manufacturers of the key pesticides studied, several noted that their production peaked in late winter or early spring and some stated that they did not produce during the summer months. On the other hand, most companies do produce the year around and also may formulate on-site so that extensive storage facilities are required. Production site storage in bulk or tank car quantities is sometimes practiced, but long-term storage appears to be more often in drums.

Good storage practices dictate that different pesticides be stored separately or at least in well marked locations within a warehouse. In cases in which a company handles more than one pesticide at a given location, special care is usually taken to keep herbicides well segregated from fungicides and insecticides, but pesticides which are similar chemically and in activity may be produced in the same equipment and stored in the same area.

The storage facilities of the major producers appear to be generally well regulated to prevent accidental losses of pesticides during handling and storage and well equipped with fire protection. These facilities, however, are not as frequently diked as are the production areas. Similarly, most companies appear to specify such fire protection equipment as automatic sprinkler when they use public warehouses, but few of these warehouses are diked. Thus, warehouse fires which require the use of large amounts of water are a serious potential source of pesticide pollution. The further the warehouse is from the control of the primary producer, the greater the potential in an estimated majority of cases.

The mode of transporting pesticides from the production sites to the customer, distant storage facility, or formulator varies widely because of the variations in location of production sites and use areas. The products are shipped by various combinations of rail and truck, depending on the nature of the material, packaging practices, and the marketing structure. Shipping containers range in size from gallon cans and small bags to 6,000-gal. tanks.

The packaging and transportation practices generate different pollution potentials for different products. Most of the highly toxic organophosphates such as disulfoton and the parathions are never shipped in tanks--only drums. Similarly, the toxic carbamates are shipped as 50-lb bags in the case of carbaryl, and in two specially modified tank trucks in the case of the extremely toxic aldicarb. The shipment of liquid pesticides (and particularly toxic organophosphates) in drums reduces the potential for a large spill of hazardous material, but the handling and disposal of the emptied drums is a serious problem. On the other hand, most of the toxaphene is shipped in tank cars and trucks and transferred directly into company owned bulk storage tanks at the formulators' location, and no used drums are generated in this step.

A significant difference in pollution potential exists between transport in tank cars and tank trucks. Tank cars are either company owned or leased by the company from the railroad and are used over and over for the same or a similar product. If the tank car requires cleaning between shipments or before return to the railroad (as during the slack season), cleanup is done at the production site and wastes go to the company's detoxification or disposal system. Tank trucks, on the other hand, normally are received from the trucking firm in a clean and dry condition, are filled, then transported to the destination and unloaded by the trucker who then has the responsibility for cleanup before the truck goes to another customer. The trucking firm, however, normally does not have the detoxification and decontamination equipment nor the technical expertise available at the manufacturer. Washings are probably most often disposed in the most convenient manner.

Pesticides which are packaged in cans, drums, and bags are very often shipped from the manufacturers only in truckload or carload lots. In many cases, however, as the distribution system fans out, consignment becomes less than carload or truckload lots and the pesticides become part of mixed lot shipments. In such cases, the manufacturer loses some control over the product, and it may be shipped together with flammable solvents or other material which might increase the pollution potential.

By-Products and Wastes

The production of virtually every pesticide produces aqueous or gaseous streams and frequently solid wastes which contain unreacted ingredients, unrecovered products and solvents, and unavoidable or undesirable by-products. Extensive efforts are usually made to minimize by-products and to recover, recycle or otherwise prevent these process losses from occurring. For each process, however, a balance point is eventually reached between the expense of recovery and the value of the recovered product. In the past, the economic considerations were frequently dominant and process losses were included as unavoidable costs. Under the recent emphasis on environmental contamination, further efforts have been made to recover many previously lost materials--even when economics indicated that it was more expensive to do so--and most pesticide manufacturers have invested in or are in the process of building extensive waste treatment facilities wherein those wastes which cannot be recovered are degraded to acceptable levels or disposed by state approved methods. A summary of the principal wastes generated and the disposal methods employed by the producers of the key pesticides is shown in Table B-5.

While most of the companies interviewed indicated that they are presently in conformity with local standards, a quantitative picture of the overall pollution potential could not be developed during this program. Under the 1899 Refuse Act Permit Program, those companies which discharge to navigable water have been filing discharge data with the Corps of Engineers, but unfortunately, these data became available only very late in our study. Those data which we have seen, however, indicate that production processes as presently employed for several product lines lead to surprisingly large losses of active ingredients and toxic raw materials or by-products.

Table B-5. SUMMARY OF MANUFACTURING WASTES AND DISPOSAL

	Liquid wastes		Solid or other wastes	
Pesticide	**Source**	**Disposal**	**Source**	**Disposal**
DDT	Processing solutions	Evaporative basin	Reactor solutions	County dump
Aldrin	Floor washings, etc.	Evaporative basin	Lime slurry	Lime pit
Dieldrin	Process solutions	Evaporative basin	Filter solids	Incinerate
Chlordane	Process solutions	Deep well	Filter solids	Clay pit
Toxaphene	Pinene-camphene plant	Bio-treatment plant		
	Process solutions	Neutralize, hold, discharge	Filter solids	Solid waste
Disulfoton	Process solutions	Secondary treatment plant	Filter solids, etc.	Commercial landfill
			H_2S	Flare
Malathion	Process solutions	Barge to deep sea	Filter solids	Landfill (with lye)
Phorate	Process solutions	Barge to deep sea	Filter solids	Landfill
			Mercaptan losses	Flare
Parathion	Process solutions	Waste treatment plant	H_2S, S	Flare, incinerate
Carbaryl	Process solutions	Secondary waste treatment	H_2, $COCl_2$, amine	Flare
			Heavy residues	Incinerate
Aldicarb	Process solutions	Neutralize, secondary waste treatment	Process vents	Flare
2,4-D	Process solutions	Trickling filter, biological waste treatment plant	Filter solids and still bottoms	Incinerate, scrub
2,4-D	Process solutions	Charcoal absorption/ filtration treatment	-	-
2,4,5-T	As per 2,4-D			
2,4,5-T	Process solutions	Oxidation pond, discharge	Solids	Landfill
Atrazine	Process solutions	Most to river; some to deep well		
Trifluralin	Process solutions	Biological waste treatment	NO_x	Scrubber
Alachlor	Process solutions	Discharge	Solvent	Fuel
Captan	Process solutions	Hold, discharge	Gas streams	Scrub, vent
Methyl bromide			Gaseous wastes	Scrub, waste treatment plant
Pyrethrin	Aqueous still bottoms	Sewer	Process solids	Storage
			Filter solids	Landfill
Bacillus t.	Process solutions	Sterilized, biological waste treatment	Process air	Incinerate or filter
Bacillus t.	Process solutions	Evaporation pond		
$HgCl_2$ - Hg_2Cl_2	Process solutions	Hg-recovery; Discharge to sewer	Filter solids NO_x, H_2S	Hg recovery Recovery?

The producers of the persistent chlorinated hydrocarbons use an evaporative basin in part* for DDT, an evaporative basin for aldrin and dieldrin, and deep well disposal for chlordane. Therefore, these plants have no discharges subject to the 1899 Act. The evaporative basins require a word of further comment--evaporative and wind blown losses from these facilities require evaluation and the long-term future of the basin should be considered, e.g., what happens if the production site is closed 25 years from now and converted to other uses?

Deep well disposal is used by several pesticide producers in states where that practice is permitted, and deep sea disposal is practiced by a number of producers in the eastern seaboard area.

The air pollution aspects of pesticide production are essentially without quantitative data. A small amount of information on levels of certain pesticides in ambient air samples has been reported, but almost no emissions data on specific pesticides from a given plant have been published. These data are much needed.

A number of minor sources of pesticide losses were noted during the interviews. One receiving the attention of a few companies is the small amount which collects on workers' clothing, wipe cloths, etc. Good data on losses on shoes, etc., are simply unavailable, although one company noted that they had reduced miscellaneous losses from 150 to 2 lb/day by increased attention to small details. Some companies furnish all production workers with clothing which is then collected and washed or prewashed in a company-run laundry from which the wastewater goes to detoxification treatment. On the other hand, some pesticide producers utilize commercial laundries which may wash the company's materials separately from all others, but do not use any special detoxification treatment. The use of disposable clothing and cloths also requires special attention to see that these materials are incinerated rather than going to a landfill if the contaminant is a persistent pesticide.

Another potential pollution source is contaminated solvents which might be sent to a solvent reclamation service. None of the major manufacturers appear to do this but small producers or formulators may (particularly with solvents used for cleanup purposes). The pesticide content of the solvents may be concentrated in still bottoms or on filter media which are not detoxified.

For some plants, the pollution caused by loss of active ingredients is apparently less significant than that caused by unrecovered by-products such as H_2S, which is flared to SO_2, or particulates from fuel combustion. A plant which produces 10 million pounds per year of most thioorganophosphates could emit over 2 million pounds of SO_2, which would compare with that emitted from a small electric power plant. Depending on the fuel used for process heat and the air pollution controls installed, such a plant might also produce 5 to 10 million pounds per year of particulate pollutants (fly ash, etc.). By comparison, the amount of active ingredient discharged through the waste treatment plant would probably be less than 10,000 lb/year.

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* DDT-containing liquids to go to an approved county Class 1 dump.

The by-product which is common to many pesticide production processes (including chlorinated hydrocarbons, organophosphates, triazines, carbamates, captan, and others) is salt. A large production plant may generate several million pounds per year of salt which with few exceptions is not recovered and is discharged to the river or through waste treatment plants. The effects of these discharges are probably small, but may require further evaluation.

Cleanup and Decontamination of Equipment

Equipment cleanup is an integral part of pesticide manufacture. This operation is both time consuming and expensive, and therefore, is kept to an absolute minimum. Equipment cleanup is generally required for one of two reasons: (a) for equipment maintenance or (b) for quality control purposes.

Repair and preventive maintenance of production equipment is a continuing process not only because of the types of equipment used, but also in many cases because of the age of the production facility. Corporate philosophy on maintenance varies from scheduled shutdowns of the complete production unit to only unscheduled shutdowns of specific items of equipment for needed repair. Generally, continuous processes require a scheduled shutdown whereas batch operation can be maintained on a less rigid schedule. In either case, the equipment must be emptied of toxic material before it can be opened for inspection or repair.

Quality control necessitates the cleanup of production equipment when the same facility is used for production of different active ingredients to prevent possible cross-contamination. Production scheduling that minimizes the number of product changes is used to reduce this type of cleanup as much as possible. Product changeover usually involves cleanup of only that portion of the process that would contain potential contaminants. Cleanout procedures generally involve flushing the production system with a solvent or in some cases with steam. Wastes from these cleaning operations normally go into the plant's process/waste system.

The pollution potential associated with equipment decontamination and cleanup is not particularly significant. First of all, only a small quantity of active material is involved in this operation, much less than 1% of the equipment capacity. Of more importance is the fact that wastes generated by equipment cleanup in most cases go to the plant waste treatment system or in some cases can be recycled to the production unit. Thus, the pollution that could result from discharge of these wastes is primarily dependent on the efficiency of the waste handling system.

Safety Practices

Safety practices in the pesticide production industry are designed for both the protection of the workers and the containment of highly toxic or dangerous chemicals. The degree and sophistication to which safety measures are used are primarily dependent on the hazard involved.

Two types of pesticides require special environmental control: (a) the organophosphates and N-alkyl carbamate because of their anticholinesterase activity, and (b) the chlorinated hydrocarbons and inorganics such as mercury because of their stability and persistence. Effects from these, as well as other toxic pesticides, may be produced by swallowing, breathing or absorption through the skin. Personnel protection measures and devices are designed to minimize exposure.

Coveralls, boots, gloves, goggles, and a variety of respiratory devices are used to protect production workers. In addition, exhaust ventilation systems are used where there is a potential for atmospheric vapor, spray or dust containing active ingredients for a hazardous raw material or intermediate. These devices seem to protect personnel from respiratory and dermal routes of intoxication. Protection against ingestion of toxic materials is dependent on demanding high standards of personal hygiene of the individual worker.

The facility for manufacturing aldicarb, one of the most toxic pesticides made in the United States, utilizes highly refined precautions, including air suits for maintenance and decontamination and glove-cabinets at toxic sample points. Respirators are issued to all personnel who come on the plant site. Less toxic pesticides, such as carbaryl, only require the use of standard personnel safety equipment.

The containment practices and equipment used are also commensurate with the hazard involved. Fire, explosion, and toxicity risks are considered. Control devices commonly used for containment include diking the production area, vacuum operation of process vessels, and caustic scrubbing of process vents.

Medical facilities are a part of the overall safety program found at pesticide plants. Both preventive medicine and first aid services are provided. Typical medical services include a periodic physical examination, first aid for minor cuts or burns, and periodic cholinesterase tests for employees potentially exposed to anticholinesterase pesticides (organophosphates and carbamates).

The potential for environmental damage resulting from inadequate safety equipment and procedures apparently does exist for some facilities. Better contingency plans specifically designed to handle emergency situations--fires, explosions or vandalism--are needed for some pesticide production plants.

GENERAL CONCLUSIONS

The major pesticide producers have, on the whole, extensive wastewater treatment facilities. Many of these are new or newly modified and many are under construction or in design, but some still have little or no effective treatment procedures at some facilities. The disposal of liquid wastes from pesticide manufacture varies widely with different companies, different products, and different geographical locations. Methods being used include: many varieties of neutralization, oxidation, settling, and holding ponds and also secondary and biological waste treatment plants (all of which are followed by discharge to a stream or lake); evaporation basins (which have no outfall); deep well disposal; deep ocean disposal; and incineration. Unfortunately, data on the discharge of effluents to navigable waters are only beginning to be made available under the "1899 Refuse Act" for disposal of materials into navigable waters. Pesticide producers were scheduled to submit discharge data to the Corps of Engineers at a time when this study was nearing completion, and very few data were available in time to be evaluated. Preliminary review, however, indicates that production processes as presently employed for several product lines do lead to sizable losses of active ingredient, toxic raw materials, by-products, etc., and that these are often not detoxified by the waste treatment facilities, e.g., discharges of active ingredients range from a few pounds per day to over 1,000 lb/day for some products. These data clearly show the need for a systematic study of the scope and effects of these discharges for all producers. On the other hand, four of the major persistent chlorinated hydrocarbon insecticides are now produced in facilities which do not discharge liquid wastes to a river, i.e., they are using evaporative basins, deep well, etc. The evaporative basins pose two problems on which we recommend receive further study: (a) what are the long-term losses of persistent pesticides by evaporation and wind? and (b) what is the disposition of the slowly accumulating sediment or sludge (which is probably highly contaminated with pesticides) in the event of periodic cleanout over the years or in the event that the pesticide production is discontinued and the area used for other purposes? In the case of one major chlorinated hydrocarbon, toxaphene, better analytical techniques are needed to establish whether it is persistent because wastes from this production plant are discharged.

The production processes have numerous potential sources of pollution in addition to the primary liquid waste streams, including air emissions, solid wastes, and miscellaneous liquid wastes. The major producers appear to be cognizant of these sources and exercise controls to satisfy local requirements.

In a number of cases, solid or liquid wastes containing active ingredients go to approved landfills or other burial sites without detoxification, e.g., a liquid waste which apparently contains DDT goes to an approved Class 1 dump in California. At a few facilities high efficiency incinerators are used to dispose of such wastes and we recommend this practice.

Data on air emissions of pesticides are not yet available from production plants and are much in need. The major producers have expended much effort to install baghouses, scrubbers, and other air pollution controls, but data on loss of active ingredients through these devices are needed.

Some of the biggest sources of pollution from the major manufacturers are not from the active ingredient (i.e., the pesticide) but from unrecovered by-products such as H_2S (which may be flared to SO_2). Particulate or gaseous pollutants from incomplete combustion of fossil fuel may be bigger sources of pollution than loss of active ingredient for some plants.

Nearly all of the basic facilities and equipment now in use for pesticide manufacture and formulation were designed and built prior to the present age of intense concern about environmental quality. Even in the case of one large completely new facility additional pollution control procedures and systems had to be added on after the basic plant was designed in an attempt to meet new and higher standards. This situation is not unique to the pesticide industry, but prevails with most manufacturing facilities and processes currently in use. However, this problem is of special importance in the pesticide industry because this industry produces biologically active chemicals which are apt to have higher potential for causing environmental damage than do the effluents discharged from most manufacturing processes.

Numerous examples were noted wherein companies have recently modified their production and waste disposal facilities to decrease the amounts of wastes generated or lost, e.g., improved recycle, recovery, and decontamination of by-products, use of lined settling basins to avoid seepage, etc.

Most of the production equipment is dedicated to one product or to two very similar products so that cleaning wastes are minimal.

A host of smaller potential pollution sources were noted, some of which have received attention by some producers, but not by others. Carryout of pesticides on shoes and clothes is prevented by sending company provided workwear along with wipe cloths, etc., to special laundries, followed by recycle or detoxification of the wash liquid. Wash basin or lavatory washwater is sent to the waste treatment plant rather than discharged with sanitary wastes, and the proper disposal of "bottoms" from solvent recovery operations.

The formulation of pesticides is probably a larger source of environmental pollution than is the initial production. The formulation is done in some cases by the manufacturer at the production site, but in most cases, it is not. Formulators process hundreds of pesticides into thousands of finished products. By the nature of this arrangement many of the formulators have relatively small facilities, and many of the formulation runs are relatively short. The combined result is that formulators with few exceptions have less extensive waste treatment facilities than do the manufacturers, but they generate considerably more wastes from equipment cleanup. However, the majority of the formulators probably send liquid wastes to municipal sewer systems so that no data are available on the amounts discharged. These smaller businesses are also more apt to send pesticide containing solvents to commercial solvent reclamation services (where the fate of the pesticide is uncertain) than is the manufacturer.

One problem faced by pesticide formulators wishing to improve their pollution abatement systems and procedures is the lack of authoritative, practical information on how to accomplish this. Several formulating companies whom we interviewed expressed disappointment and dissatisfaction with engineering firms to whom they had turned for help in developing practical systems and procedures which would meet the environmental quality standards set by local, state and/or federal regulatory and enforcement agencies.

A closely related problem is that of dealing with catastrophes. While most basic pesticide manufacturers (especially those where the pesticide production is integrated into a larger chemical manufacturing complex) have emergency procedures, contingency plans on how to handle emergencies such as fires, explosions, floods, etc., were inadequate or absent in most independent pesticide formulating plants and also in many public warehouses which handle concentrated pesticides. Recent history indicates, however, that emergencies in which large quantities of toxic materials are suddenly released into the environment can and do occur.

We therefore conclude that there is an urgent need for the development of principles and procedures by which pesticide formulating and warehousing enterprises can minimize or completely eliminate the release of toxic chemicals into the environment, especially into waterways. Such information is needed (a) for their normal operations, and (b) for emergencies. We recommend that steps be taken early to develop this type of information and furnish it to the pesticide formulating industry and to those involved in warehousing large quantities of pesticides.

The transportation of pesticides, as with many other products, causes increased chances of accidental breakage, spills, and losses. The potential is probably higher in the case of the concentrated active ingredient than it is with more dilute formulated products, but varies with the packaging and shipping practices. Overall, the pesticide industry has had relatively few major spills, but the potential remains inherent in the transportation of hazardous materials.

Of smaller scope, but of importance we believe, is the increased pollution potential of tank trucks over railroad tank cars in regard to cleanout procdures. Cars are frequently dedicated, require only occasional cleanout, and this is done at the manufacturer's site with wastes going to treatment. The trucks are most often leased one way and are cleaned by the operator at a point remote from detoxification facilities.

Another important pollution point related to the need to transport pesticides is the inability to empty the standard 5- and 55-gal. metal drums completely. These drums may often be reused for formulated products, etc., and losses at the manufacturer/formulator/packager level are not nearly so large as those at the consumer level, but new designs are needed which permit complete drainage.

The warehousing of finished pesticidal products and the marketing of pesticides are smaller sources of pollution, but losses in this area are frequently disposed to the nearest sewer or trash can.

Overall, the environmental impacts from pesticide manufacturing/formulating/packaging/marketing activities appear to be small compared to those resulting from consumer use of these products, but those negative impacts of the former activities have zero benefit/cost ratios and should be minimized. On the other hand, the costs of reducing all pollutants to zero are very large. Regulations and legislation in this area must consider that unrealistic standards will drive many small producers from the industry and preclude the entry of others who would previously have entered. The large producers, who generally already have a very large investment in pollution control equipment, will be best able to meet the most stringent control regulations and will probably do so (with added costs passed on to the buyer) if the product involved is much in demand by the public.

APPENDIX C

PESTICIDE TOXICITY DATA

Appendix C lists acute oral, dermal, and inhalation toxicities of pesticides on test subjects together with additional pertinent information, e.g., U.S. Occupational Standards. In general the toxicity data refer to rats but references to other species including humans are also given.

The compilation of common and chemical names of pesticides is taken from Caswell[1/] and the corresponding toxicity data are taken from the NIOSH Registry of Toxic Effects of Chemical Substances.[2/] In particular, the appendix connects the Caswell Accession Number for a pesticide to the NIOSH Registry Number (Cross-Reference Number). This permits ready access to toxicity data for a given pesticide listed by Caswell and provides the opportunity for immediate confirmation and source identification from the NIOSH Registry.

In some cases pesticide toxicity data are not indicated in the NIOSH Registry. This does not mean that a substance is not toxic but rather the Registry selection has primarily been made on the basis of a lethal single dose, represented by a LD_{50}, LC_{50} or similar data types. In these cases the pesticide toxicity manufacturers' technical data sheets should be consulted.

The appendix also indicates those pesticides which are suspected chemical carcinogens or which cause neoplastic (tumor) toxic effects. Those pesticides which are known or suspected carcinogens or having neoplastic effects are also given in the NIOSH Suspected Carcinogens Subfile.[3/] The NIOSH Registry numbers in the subfile are identical to those in the NIOSH Registry.

Various abbreviations appear in the NIOSH Registry and have been utilized in preparing Appendix C. A complete listing of abbreviations follows:

BDW - Wild bird species
CL - Ceiling concentration
CAR - Carcinogenic effects
CAT - Cat
CKN - Chicken
D - Day
DOG - Dog
fb - Fibers
gm - Gram
GPG - Guinea pig
H - Hour
HAM - Hamster
HMN - Human
IHL - Inhalation
IMP - Implant
IMS - Intramuscular
IPL - Intrapleural
IPR - Intraperitoneal
ITR - Intratracheal
IVN - Intravenous

IVG - Intravaginal

Kg - Kilogram

LC50 - Lethal concentration 50% kill

LCLo - Lowest published lethal concentration

LD50 - Lethal dose 50% kill

LDLo - Lowest published lethal dose

MAM - Mammal (species unspecified)

MAN - Man

M - Minute

m^3 - Cubic meter

ml - Milliliter

mg - Milligram

MUS - Mouse

NEO - Neoplastic effects

ORL - Oral

PAR - Parenteral

ppb - Parts per billion (v/v)

ppm - Parts per million (V/V)

RAT - Rat

RBT - Rabbit

SCU - Subcutaneous

SKIN - Skin effects

SKN - Skin

TCLo - Lowest published toxic concentration

TDLo - Lowest published toxic dose

TL_m 96 - Aquatic lethal concentration 50% kill, 96 hr

TLV - Threshold limit value

TRK - Turkey

TWA - Time weighted average

µg - Microgram

UNK - Unreported

USOS - U.S. Occupational Health Standard

W - Week

WMN - Woman

Y - Year

REFERENCES

1. Caswell, R. L., M. L. Alexander, H. Boyd, Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels, 3rd Edition, Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C., December 1975.

2. Registry of Toxic Effects of Chemical Substances, H. E. Christensen, ed., T. T. Luginbuyhl, ed., U.S. Department of Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, Rockville, Maryland, June 1975.

3. Suspected Carcinogens, A Subfile of the NIOSH Toxic Substances List, H. E. Christensen, ed., T. T. Luginbyhl, ed., U.S. Department of Health, Education, and Welfare, Public Health Service National Institute for Occupational Safety and Health, Rockville, Maryland, June 1975.

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
1	-	-	-	-	-	-
2	-	-	-	-	-	-
2A	-	866	-	-	-	TB47600
3	-	3,310	-	-	USOS-Air TWA 10 ppm	AF12250
3A	-	1,780	-	LDL_o 1,000 ppm/4H	USOS-Air TWA 5 ppm	AK19250
3B	-	-	-	-	-	-
4	-	5,300 RBT	-	-	USOS-Air TWA 1,000 ppm	AF31500
4A	-	900	-	-	-	GN48300
5	-	-	-	-	-	-
5A	-	400 MAM	-	-	-	GN48600
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	TDL_o 50 MUS	14 SCU-MUS	-	-	AR96250

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
9	-	46	562 RBT	LCL_o 8 ppm/4H	USOS-Air TWA 0.1 ppm	AS10500
10	-	93	280 RBT	LCL_o 500 ppm/4H	USOS-Air TWA 20 ppm (skin)	AT52500
11	-	1,200	-	-	-	AE12250
11AA	-	6,300 RBT	8,285 MUS	-	USOS-Air 1,000 ppm	KQ63000
11A	-	1	2.5	-	-	UE22750
12	NEO	67	98	-	USOS-Air TWA 0.25 mg/m^3 (skin)	IO21000
12A	-	-	-	-	-	-
13	-	500	-	-	-	BO25000
13B	-	-	-	-	LDL_o 200 mg/kg UNK-MUS	RG43750
14	-	-	-	-	-	-
15	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
16C	-	400	-	-	-	BO31500
16V	-	4,000	-	-	-	BO70000
17	-	-	-	-	-	-
18A	-	730	-	-	-	BO32000
18H	-	730	-	-	-	BP64800
18K	-	500	-	-	-	BQ54250
19AA	-	300	-	-	-	BO33250
20	-	-	-	-	-	-
21	-	-	-	-	-	-
22	-	230	-	-	-	NX52500
23E	-	410	125 SCU-RBT	-	-	BQ78750
24	-	-	-	-	-	-
25	-	LDL_o 680	-	-	-	GZ19250
26	-	LDL_o 69	LDL_o 53 RBT	LC_{50} 165 ppm/4H	USOS-Air TWA 2 ppm (skin)	BA50750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
27	-	148	-	-	-	NX82250
27A	-	-	-	-	-	-
28	-	6	-	-	USOS-Air TWA 0.5 mg/m^3	YT92750
28A	-	-	-	-	-	-
29	-	3,700	-	-	-	BD05250
29A	-	-	-	-	-	-
30	-	-	-	-	-	-
31	-	-	-	LCL_o 1 ppm	-	BD14000
31A	-	-	-	-	270 IPR-MUS	BD17000
32	-	1,100	-	-	-	XY91000
33	-	600	-	-	-	TE15750
33A	-	-	50 SCU-MUS	-	-	AR73000
33B	-	2,850 MUS	-	-	-	DG14000

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
33C	-	-	-	-	-	-
33E	-	2,200	-	-	-	XZ29900
36	-	1,210 IVN-MUS	-	-	-	TY29000
37	-	-	-	-	-	-
37A	-	10	48	-	-	TA14000
38	-	21	5 SCU-MUS	-	-	US17500
40	NEO CAR	1,100	TDL_o 54 SCU	-	TLD_o 113 g/kg ORL-MUS	XZ38500
41	-	350	-	LCL_o 2,000 ppm/4H	USOS-Air TWA 50 ppm	BO08750
41A	-	-	-	-	-	-
41B	-	-	-	-	-	-
41C	-	-	-	-	-	-
42	-	-	-	-	LD_{50} 96 mg/kg IVN-MUS	BP19250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
43	-	LDL_o 100	-	-	-	GQ94500
44	-	350	-	-	-	BQ96250
44A	-	-	-	-	-	-
44AB	-	-	-	-	-	-
44B	-	-	-	-	-	-
44C	-	-	-	-	-	BR90500
45	-	-	-	-	-	-
45A	-	-	-	-	-	-
45B	-	-	-	-	-	-
45C	-	-	-	-	-	-
46	-	-	-	-	-	-
47	-	1,600	-	-	USOS-Air TWA 15 mg/m^3	WO61250
48	-	58	-	-	-	BS45000
48A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
49	-	-	-	-	-	-
49A	-	7,400 RBT	-	LCL_o 5,200 ppm	USOS-Air TWA 100 ppm	AJ19250
49B	-	-	-	LCL_o 2,000 ppm/4H	-	SA31500
50	-	3,080	2,000 RBT	-	-	SM68250
50A	-	-	-	-	-	-
50B	-	-	-	-	-	-
51	-	LDL_o 10	-	-	-	BV43750
51A	-	-	-	-	-	-
51B	-	2,090	-	-	-	BZ89250
51C	-	440	1,400	LCL_o 250 ppm/4H	USOS-Air TWA 5 ppm (skin)	BW66500
51D	-	-	-	-	-	-
52	NEO	-	TDL_o 3,300 SCU	-	-	CA93500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
52A	NEO	TDL_o 90	-	-	-	CB47250
52B	-	LDL_o 30	21 SCU-MUS	-	-	CD03500
53	-	115	55 SCU-MUS	-	USOS-Air TWA 0.5 mg (Sb)/m^3	CC68250
54	-	-	-	-	-	-
55	-	-	-	-	USOS-Air TWA 500 ppm	SE75250
56	-	-	-	-	USOS-Air TWA 500 µg (As)/m^3	CG07000
57	-	8	-	-	USOS-Air TWA 500 µg (As)/m^3	CG22750
58	-	-	-	-	-	-
59	-	20	LDL_o 15 SCU	-	USOS-Air TWA 0.5 mg (As)/m^3	CG33250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
60	-	-	-	800 μg/kg IVN-RBT	-	CH81000
60A	-	20	LDL_o 15 SCU	-	-	CG33250
61	CAR	-	-	TDL_o 12 mg/m^3	NIOSH Rec'd STD TWA 2fb/ml	CI64750
61A	-	-	-	-	-	-
62	-	-	-	-	-	CI99000
62A	-	-	-	-	LD_{50} 5,000 mg/kg UNK-MUS	FD11900
62B	-	-	-	-	-	-
63	-	1,750	-	-	-	XY56000
63A	CAR	TDL_o 37 g/kg	TDL_o 2,625	-	-	BY35000
63B	-	1,800 RBT	-	-	-	XY32800
64	NEO	1,000	TDL_o 17 g/kg SCU	-	-	CN14000
65	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
66	-	-	-	-	-	-
66A	-	25 MUS	LDL_o 1,300 SCU-MUS	-	-	CP01750
66B	-	-	-	-	-	-
68	-	600	-	-	-	FD77000
69	-	LDL_o 630	-	-	-	CQ86000
70	-	175	-	-	-	CR05250
71	-	-	-	-	-	-
71AA	-	950 UNK	-	-	-	GZ15000
71A	-	-	-	-	-	-
72	-	-	-	-	-	-
73	-	-	-	-	LDL_o 200 mg/kg ORL-HMN	GL88300
73A	-	-	-	-	-	-
74	-	-	-	-	-	-
75A	-	100 BWD	-	-	-	DD64750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
75BA	-	1,100	2,500	-	-	DK99000
75C	-	-	-	-	-	-
75D	-	-	-	-	-	-
76	-	1,300	LDL_o 5,000	-	-	CU43750
77	CAR	3,800	TDL_o 1,232 MUS	LC_{50} 10,000 ppm/7H	USOS-Air TWA 10 ppm	CY14000
78	CAR	88	500	-	USOS-Air 500 $\mu g/m^3$ (skin)	GV49000
79	CAR	500	-	-	-	GV35000
79AA	-	-	-	-	-	-
79A	-	-	-	-	-	-
80	-	56 BDW	-	-	-	DG24500
81	-	3,040	-	-	-	DG08750
81A	NEO	130	TDL_o-2,000 MUS	-	USOS-Air TWA 0.1 ppm	DK26250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	 Acute Dermal-LD_{50} (mg/kg)	 Inhalation-LD_{50} (mg/kg)	 Other	NIOSH-Toxic Substances List Cross-Reference No.
81AB	-	100	-	-	-	DH61250
81B	-	-	-	-	-	-
81C	-	1,280	-	-	-	DL58600
81D	-	70	-	-	-	FB47250
81E	-	-	-	-	-	-
81EA	-	-	-	-	-	-
81F	-	1,230	-	1,000 ppm/8H	-	DN31500
82	-	1,700	-	-	-	DG42000
82A	-	-	-	-	-	-
83	-	1,700	-	-	-	GO71750
83A	-	-	-	-	-	-
83B	-	-	-	-	-	-
83BB	-	-	-	-	-	-
83C	-	400	-	-	-	BO31500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD$_{50}$ (mg/kg)	Acute Dermal-LD$_{50}$ (mg/kg)	Inhalation-LD$_{50}$ (mg/kg)	Other	
83D	-	100	-	-	-	BO75250
83E	-	1,500	-	-	-	GZ13100
84	-	90	250	-	-	XK84000
85	-	500	-	-	-	OF08750
85A	-	-	-	-	-	-
86	-	58	720	-	-	GQ56000
87	-	3,280	2,500 RBT	-	USOS-Air TWA 0.2 ppm	DU80500
87A	-	-	-	-	-	-
88	-	-	-	-	-	-
88A	-	-	-	-	-	-
89	-	2,500	-	-	-	HP50750
89A	-	-	-	-	-	-
91	-	-	-	-	-	-
91A	-	4	25	-	-	TB47250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
91B	-	-	-	-	-	-
92	-	-	-	-	-	-
92A	-	475	-	-	-	IN36750
93	-	575	100	-	-	DC84000
93A	-	265	480	-	-	JO10500
94	-	-	-	-	-	-
94AA	-	345	-	-	-	UU25920
94A	-	535	-	-	-	XY38500
94B	-	1,830	-	-	-	XY40250
95	-	-	-	-	USOS-Air TWA 5 mg/m^3	TI03500
95A	-	-	-	-	-	-
98	-	1,400	-	-	-	XY43950
98A	-	-	-	-	-	-
98B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
99	-	-	-	-	-	-
99A	-	-	-	-	-	-
100	-	-	-	-	-	-
101	-	194	LDL_o 1,170 RBT	-	-	JN87500
102	-	-	-	-	-	-
102A	-	-	-	-	-	-
102B	-	-	-	-	-	-
102C	-	-	-	-	-	-
103	-	-	-	-	-	-
104	-	-	-	-	-	-
105	-	-	-	-	-	-
106	-	-	-	-	-	CI99000
106A	-	-	-	-	-	-
107	-	LDL_o 800	-	-	-	ED07800

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
108	-	2,660	-	-	-	VZ22750
109	-	2,660	1,740 SCU-MUS	-	-	ED45500
111	-	3,400	-	-	-	YQ92750
111A	-	-	-	-	-	-
112	-	-	-	LCL_o RBT 180 ppm/7H	USOS-Air TWA 0.1 ppm	EF91000
112A	-	100 MUS	-	-	-	AF59500
113	-	-	-	-	-	-
114	-	664	813 RBT	-	-	UA74000
114A	-	-	-	-	-	-
114C	-	-	-	-	-	-
114D	-	200	1,000	-	-	TE70000
114E	-	1,600	720 RBT	-	-	TE71750
115	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
116	-	12,500	-	-	-	RB80500
116A	-	-	-	-	-	-
116B	-	-	-	-	-	-
116C	-	5,000	-	-	-	DD21000
118	-	-	-	-	-	-
119	-	190	-	-	-	DI31500
119A	-	-	-	-	-	-
119AB	-	170	-	400 RBT	-	FC35100
119B	-	-	-	-	-	-
119BA	-	-	-	-	-	-
119C	-	LDL_o 6,000 RBT	-	-	USOS-Air TWA 150 ppm	EO17500
119D	-	-	-	-	-	-
120	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	Niosh-Toxic Substances List Cross-Reference No.
121	-	1,480	560 RBT	LCL_o 500 ppm/4H	USOS-Air TWA 50 ppm (skin)	KJ85750
121AA	-	-	-	-	-	-
121A	-	-	-	-	-	-
121B	-	90	250	-	-	XK84000
121C	-	-	-	-	-	-
122	-	-	-	-	-	-
123	-	-	-	-	-	-
123A	-	-	-	-	-	-
124	-	800 MUS	-	-	-	AD98000
124A	-	3,500	-	-	USOS-Air TWA 100 ppm	EO19250
125	-	380	-	-	-	EO33250
125A	-	-	-	-	-	-
125CA	-	483	-	-	-	XY50200

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
126	-	-	-	-	-	-
127A	-	820	-	-	-	TB49000
127AB	-	-	-	-	-	-
128	-	5,400 RBT	-	-	-	UP70000
128A	-	2,350	-	-	-	UW60250
128B	-	-	-	-	-	-
128BB	-	-	-	-	-	-
128EA	-	-	-	-	-	-
128EB	-	-	-	-	-	-
128F	-	50	LDL_o 1,500	-	-	FF91000
128FA	-	-	-	-	-	-
128G	-	-	-	-	-	-
128H	-	4,000	-	-	-	UV73500
128I	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
129	-	-	-	-	-	-
130	-	790	-	-	-	XU45500
130AA	-	5,000 MUS	-	-	-	DH19800
130A	-	406	790	500 ppm/4H	-	EQ49000
130B	-	-	-	-	-	-
130D	-	-	-	-	-	-
130E	-	3,250	2,520 RBT	-	-	SJ89250
130F	-	-	-	-	-	-
130G	-	-	-	-	-	-
131	CAR	3,900	-	-	-	WT29750
131A	-	-	-	-	-	-
132	-	1,100	-	-	-	ET01750
133	-	1,350	-	-	-	CH75250
133A	-	2,600	-	-	-	CH77000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
134	-	-	-	-	-	-
134A	-	-	-	-	-	-
135	NEO	88	TDL_o 5 SCU	-	-	EV01750
136	-	-	-	-	-	-
136AA	CAR	72	TDL_o 90 SCU	-	USOS-Air TWA 0.1 mg/m^3	EV19250
136A	-	-	-	-	-	-
136B	-	660	-	-	-	WM56000
136C	CAR	-	TDL_o 2 SCU	-	-	EV27000
136D	-	-	-	-	LDL_o 15 mg/kg HMN	PA17500
137	NEO	30	-	-	USOS-Air TWA 1 mg/m^3	CG08300
138	-	-	-	-	-	-
139	-	-	-	-	-	EV95800

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
139A	-	LDL_o 4,500	-	-	-	FN98000
139B	-	1,000	-	-	-	EV98000
140	-	1,400 RBT	-	-	-	GS60000
141	-	-	-	-	-	-
142	-	39	-	-	-	EW07000
143	-	-	-	-	-	-
144	-	-	-	-	-	EW28000
145	-	-	-	-	-	NH34850
145A	-	-	-	-	-	-
146	-	-	-	-	-	-
146A	-	-	-	-	-	-
147	-	-	-	-	-	-
147A	-	-	-	-	USOS-Air TWA 5 mg/m^3	EW31000
148	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
149	-	355	-	-	-	TX28000
150	-	-	-	-	-	-
151	-	-	-	-	-	-
152	-	-	-	-	-	EW41500
153	-	LDL_o 344 IVN	-	-	-	XN64300
154	-	210	-	-	-	OV87500
155	-	LDL_o 900 IPR	-	-	USOS-Air TWA 2 ppm	EX12250
156	-	LDL_o 2,000 RBT	-	-	-	EX14900
156A	-	-	-	-	-	-
157	CAR	-	TDL_o 25 MUS	-	-	RN85750
158	-	-	-	-	LDL_o 1.6 mg/kg IVN-CAT	RA85250
158A	-	2,500	-	-	-	GW49000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
159	-	480	-	-	TLV TWA 5 mg/m^3	GW50750
160	CAR	89	-	-	USOS-Air TWA 5 mg/m^3	FC59500
160AA	-	1,200 MUS	-	-	-	FD05250
160A	-	5	120	LD_{50} 85 mg/m^3	TLV TWA 50 $\mu g/m^3$	FB94500
160B	-	4	4	LC_{50} 14 ppm/1H	USOS-Air TWA 400 $\mu g/m^3$	GQ52500
161	-	-	-	-	USOS-Air TWA 4 mg/m^3 LD_{50} 440 IVN-MUS	FF52500
161A	-	-	-	TDL_o 6 pph	USOS-Air TWA 5,000 ppm	FF64000
162	-	-	LDL_o 300 SCU-RBT	-	USOS-Air TWA 20 ppm	FF66500
164	CAR	1,770	-	LCL_o 4,000 ppm/4H	USOS-Air TWA 10 ppm	FG49000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
165	-	10	27	-	-	TD52500
165A	-	3,200	-	-	-	RP45500
165AB	-	-	-	-	-	-
165B	-	-	-	-	-	FI41000
165C	-	-	-	-	-	-
165D	-	-	LD_{50} 2,600 SKN-RBT	-	-	MM02250
165E	-	500	-	-	-	BQ54250
165F	-	-	-	-	-	-
166	-	-	-	-	-	-
166A	-	200	250 SCU	-	-	UU49000
167	-	410	125 SCU-RBT	-	-	BQ78750
167A	-	-	-	-	-	-
168	NEO	285	620 SCU	-	-	FM87500
168A	-	3,500	-	-	-	DG19250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
169	-	-	-	-	-	-
170	-	-	-	-	-	-
171	-	4,000	-	-	LDL_o 500 mg/kg IPR	DK68250
172	-	1,950	-	-	-	XY50750
173	-	2,000	-	-	-	WQ29750
173A	-	4,287	-	-	-	YS28000
174	-	283	700	-	USOS-Air TWA 0.5 mg/m^3 (skin)	PB98000
174A	-	250	-	-	-	LQ43750
174B	-	295	-	-	-	LQ45500
175	-	140	2,100 RBT	LC_{50} 1,000 ppm/4H	-	TX98000
176	-	LDL_o 2,150	-	-	-	XB26250
177A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
179	-	-	-	LC_{50} 293 ppm/1H	USOS-Air TWA 1 ppm	FO21000
179A	-	-	-	LCL_o 500 ppm/15M	USOS-Air TWA 0.1 ppm	FO26250
179B	-	76	5 SCU	-	-	AF85750
179C	-	-	-	-	USOS-Air CL 0.05 ppm	AM63000
179D	-	-	-	-	-	-
180	-	850	-	-	-	EZ50750
181	-	500	-	-	-	XX84500
182	-	300	LDL_o 36 RBT	-	-	BX07000
182A	-	-	-	-	-	-
182B	-	-	-	-	-	-
183	-	-	-	-	-	-
183A	-	2,910	LDL_o 4,000 SCU	-	USOS-Air TWA 75 ppm	CZ01750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
183AB	-	560 MUS	-	-	-	EZ72600
183B	-	-	-	-	LD_{50} 3,000 mg/kg UNK	WQ37400
183BA	-	-	-	-	-	-
183C	-	-	-	-	-	-
185	LDL_o 213 RBT	-	-	-	-	UC01750
185A	-	-	400 SCU	-	-	FQ61250
186	-	LDL_o 420	850 RBT	-	-	SK36750
186AA	-	-	-	-	-	-
186AB	-	-	-	-	-	-
186A	-	LDL_o 4,000	-	-	-	KO11000
187	-	10	30	-	-	TB87500
187A	-	146	177	-	-	TE75250
187B	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
188	1	-	-	-	-	UV80500
188A	-	-	-	-	-	-
188AA	-	-	-	-	4,000 mg/kg UNK-MAM	YV60100
188AC	-	-	-	-	-	-
188C	-	340	-	-	-	UG14900
188D	-	-	-	-	-	-
188E	-	-	-	-	-	-
191	-	670	232 RBT	-	-	BP52500
191A	-	-	-	-	-	-
192	CAR	800	704 SCU-MUS	LCL_o 8,000 ppm/4H	USOS-Air TWA 50 ppm	FS91000
192A	-	-	-	-	-	-
192B	-	-	-	-	-	-
192C	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
193	-	-	-	-	-	-
194	-	1,200	380 RBT	-	-	AE15750
194AA	-	-	-	-	-	-
194A	-	LDL_o 100	-	-	-	OW03500
194B	-	1,600	-	-	-	US57750
195	-	-	-	-	-	-
195A	-	-	-	-	-	-
195B	-	7	27	-	-	TD18600
195BA	-	-	-	-	-	-
195C	-	-	-	-	-	-
195D	-	-	-	-	-	-
196	-	-	-	-	-	-
196A	-	-	-	-	-	-
197	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
198	-	-	-	-	-	-
198A	-	-	-	-	-	-
201	-	800	1,500	-	-	TE80500
201A	-	197	362 RBT	LC_{50} 1,070 mg/m^3	-	TX52500
202	-	-	-	-	-	-
202A	-	-	-	-	-	-
203	NEO	670	950 SCU	-	-	SK26250
203A	-	-	-	-	-	-
204	-	850	-	-	-	AG01750
204A	-	-	-	-	-	-
204B	-	-	-	-	-	-
205A	-	-	-	-	-	-
206	-	-	-	-	-	-
206AA	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
206AB	-	-	-	-	-	-
206A	-	-	-	-	-	-
206B	-	1,350	-	-	-	DB56000
207AA	-	-	-	-	-	-
207A	-	94 MUS	920 MUS	-	-	TE82250
207B	-	-	-	-	-	-
207C	-	126	-	-	-	NY28000
207D	-	1,800	-	-	-	YS64250
207DA	-	178	-	-	USOS-Air TWA 0.05 ppm	OO36750
207E	-	3,000	-	-	-	US64750
209	-	-	-	-	-	-
209A	-	-	-	-	-	-
210	-	-	-	-	-	-
210A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
210B	-	3,500	-	-	-	DV68250
211	-	-	-	-	-	-
211A	-	-	-	-	-	-
211B	-	3,500	-	-	-	DV70000
211C	-	2	200 RBT	-	-	NK53350
211D	-	1,400	-	-	-	WR57750
211E	-	165 MUS	220 MUS	-	-	TE84000
212	-	98	190	-	-	TD54250
212AA	-	-	-	-	-	-
212A	-	-	-	-	LD_{50} 3,000 mg/kg UNK-MUS	IL88420
213	-	3,960	-	-	-	WQ38500
213A	-	-	-	-	LD_{50} 1,500 mg/kg UNK-MAM	UM09600
213B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
214	-	250	-	-	USOS-Air TWA 0.1 ppm	PB63000
214A	-	150	5 SCU-MUS	LCL_o 125 ppm/4H	-	TY40250
214B	-	5	-	-	-	DD24500
215	-	-	8 RBT	-	-	WS28000
215A	-	-	-	-	-	-
215AB	-	-	-	-	-	-
215AC	-	-	-	-	-	-
215B	-	-	-	-	-	-
216	-	-	-	-	-	-
216A	-	1,500	-	-	-	XU49000
216D	-	-	-	-	-	-
216E	-	-	-	-	-	-
216F	-	-	-	-	LD_{50} 175 mg/kg ORL-MAM	AB58500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
217A	-	1,100	-	-	-	TB91000
217AB	-	-	-	-	-	-
217B	-	3,700	-	-	-	YS61250
218	-	-	-	-	-	-
219	-	30	-	-	-	FB68250
219A	-	-	-	-	-	FB85750
219AA	-	145	202	-	-	TF63000
219AB	-	941	-	-	-	TG07000
219B	-	3,000	LDL_o 400 SCU-MUS	-	-	QI77500
220A	-	-	-	-	-	-
220B	NEO	TDL_o 1,000 IMP	LDL_o 2,290 SCU-MUS	-	-	AG29750
221	-	-	-	-	USOS-Air CL 100 $\mu g/m^3$ as CrO_3	GB24500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
221AA	-	-	-	-	-	GZ19250
221A	-	2,220	-	-	-	GD64750
221AB	-	-	-	-	-	-
221B	-	4,960	-	-	-	RG50750
221C	-	-	-	-	LD_{50} 884 mg/kg IPR	GE73500
223	-	-	-	-	-	-
224	-	-	-	-	-	-
224A	-	725	-	-	-	GF86150
225	-	725	-	-	-	GF86150
226	-	3,900	-	-	-	QK89250
226A	-	-	-	-	-	GG83850
227	-	-	-	-	-	-
228	-	-	-	-	-	-
229	-	710	-	-	-	AG35000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
229A	-	22	-	-	-	GL64750
229B	-	-	-	-	-	-
230	LDL_o 110 MUS	-	-	-	-	QK91000
231	-	-	-	-	-	-
232	-	-	-	-	-	-
233	-	-	-	-	-	CG33850
235	-	-	-	-	-	-
235A	-	-	-	-	LD_{50} 9,400 mg/kg IPR-MUS	GL70400
235B	-	-	-	-	-	-
235BA	-	-	-	-	-	-
235C	-	-	-	-	-	-
236	-	-	-	-	-	-
237	-	590	-	-	-	GL73500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
238	-	-	-	-	-	-
239	-	-	-	-	-	-
240	-	-	-	-	LD_{50} 2,090 µg (Cu)/kg IPR-MUS	AH42800
241	-	-	-	-	-	-
242	-	-	-	-	LDL_o 200 mg/kg ORL-HMN	GL76000
243	-	-	-	-	-	-
244	-	-	-	-	-	-
245	-	LDL_o 110 MUS	-	-	-	QK91000
246	-	940	-	-	USOS-Air TWA 1 mg/m^3 as Cu	GL78750
247	-	-	-	-	-	-
248	-	-	-	-	-	-
248A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
248B	-	470	-	-	-	GL80500
249	-	700	-	-	USOS-Air TWA 1 mg/m^3 as Cu	GL82250
250	-	-	-	-	-	-
251	-	520	-	-	-	GL66500
252	-	-	-	-	-	-
253	NEO	-	TDL_o 156 SCU-MUS	-	-	VC52500
254	-	-	-	-	-	-
254A	-	-	-	-	-	-
255	-	-	-	-	-	-
255A	-	-	-	-	-	-
256	-	960	-	-	-	GL89000
258	-	-	-	-	-	-
259	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
259A	-	-	-	-	-	-
260	-	LDL_o 600 RBT	-	-	-	GO57750
260A	-	-	-	-	-	-
261A	-	725	-	-	-	GF86150
261A	-	242	620	-	USOS-Air TWA 5 ppm (skin)	GO61250
261B	-	-	-	-	-	-
263	-	1,454	-	-	USOS-Air TWA 5 ppm (skin)	GO59500
263A	-	460	-	-	TLV-Air 5 mg/m^3	TB38500
264	-	200	-	-	USOS-Air TWA 4.6 mg/m^3	WA96250
264A	-	1,000	-	-	-	BO90000
264B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
264C	-	940	-	-	USOS-Air TWA 1 mg/m^3 as Cu	GL78750
264D	-	-	-	-	-	-
265	-	-	-	-	-	-
266	-	470	-	-	-	GL80500
266A	-	-	-	-	-	-
266B	-	125	-	-	-	GS59500
266C	-	-	-	-	-	-
267	-	-	LDL_o 39 SCU-MUS	LC_{50} 118 ppm/30M	-	GT22750
267A	-	2	105	-	-	TE87500
268	-	32	-	-	-	OW17500
268A	-	995 MUS	-	-	-	TF70000
268AB	-	79	122 SCU-MUS	-	-	TB17500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
268AC	-	1,680	-	-	-	XZ18300
268B	-	9	23 RBT	-	-	NJ64750
268BA	-	-	-	-	-	-
268C	-	4,500	-	-	-	QE06100
268D	-	-	-	-	-	-
269	-	1,297 MUS	-	-	USOS-Air TWA 300 ppm	GU63000
270	-	1,620	1,000 RBT	LCL_o 2,000 ppm/4H	USOS-Air TWA 50 ppm	GW10500
270A	-	2	3 SCU	-	-	MA43750
271	-	-	-	-	-	-
271AA	-	-	-	-	-	-
271A	-	1,500	-	-	-	YS78750
271B	-	-	-	-	-	-
271BB	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
271BC	-	190	-	-	USOS-Air TWA 100 μg/m^3 as Sn (skin)	WH87500
271C	-	35	450	-	-	FB80500
271CC	-	-	-	-	-	-
271D	-	1,200	-	-	-	XY53800
271E	-	-	-	-	-	-
272	-	215	-	-	-	GZ10500
272B	-	160	-	-	-	TF75250
273	-	-	-	-	-	-
273AA	-	-	-	-	-	-
273AB	-	-	-	-	-	-
273A	-	3,860	-	-	-	UF12250
273B	-	LDL_o 300 MUS	-	-	-	WM96250
274	-	1,200	-	-	-	DT82250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
275	CAR	95	345	-	-	PC85750
275A	-	4,720	-	LC_{50} 4,000 mg/m^3 MUS	-	HE43750
275B	-	700	310 RBT	-	-	TA21000
276	-	-	-	-	-	-
276A	-	-	-	-	-	-
277	-	-	-	-	-	-
277A	-	-	-	-	-	-
277B	-	-	-	-	-	-
278	CAR	500	TDL_o 2,600 SCU	-	-	UP80500
278A	-	570	-	-	-	UP82250
278AA	-	1,775	-	-	-	HF17500
279	-	1.7	8.2	-	USOS-Air TWA 100 mg/m^3 (skin)	TF31500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
279A	-	-	-	-	-	-
279B	-	-	-	-	LD_{50} 350 mg/kg as Fe IVN-MUS	HH94500
280	-	4,000	-	-	USOS-Air TWA 50 ppm	SA91000
280A	-	5	145 RBT	-	-	TD54500
282	-	-	-	-	-	-
283	-	-	-	-	-	-
283A	-	89	-	-	-	FB84000
284	-	700	360	-	-	AB52500
285	-	-	-	-	-	-
285A	-	890	-	-	-	TD56000
286	-	-	-	-	-	-
286AA	-	-	-	-	-	-
286A	-	610 MUS	-	-	-	BV82250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
287	-	173	1,400 RBT	LC_{50} 103 ppm/8H	-	TX87500
287AA	-	-	-	-	-	-
287A	-	1,167	-	-	-	EG70000
287AB	-	-	-	-	-	-
287AC	-	-	-	-	-	-
287B	-	-	-	-	-	-
287C	-	-	-	-	-	-
289	-	410	-	-	-	VN82250
290	-	-	-	-	-	-
291	-	500	-	-	-	DB16500
291A	-	3,510	-	-	-	GO78750
291B	-	-	-	-	-	-
291C	-	-	-	-	-	-
292	-	-	-	-	USOS-Air TWA 5 mg/m^3	TI08750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
293	-	-	-	-	-	-
294	-	-	-	-	-	-
295	-	1,040	-	-	-	DG75250
296	-	330	790	-	-	TE78750
297	-	2,710	1,350 RBT	-	-	DI35000
297AA	-	250	-	-	-	TF03500
298	-	1,300	-	-	-	QL75250
298A	-	1,870	-	-	-	EZ40250
299	CAR	395	2,000 RBT	-	-	EZ82250
300	-	3,500	-	-	-	DG19250
301	-	-	-	LCL_o 707 ppm/7H	-	CZ45000
302	-	2.7	-	-	-	XY71750
304	-	-	-	-	USOS-Air TWA 1,000 ppm	PA82000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
304A	-	-	-	-	-	-
305A	-	500	1,000	-	-	W064750
306	-	-	-	-	USOS-Air TWA 0.2 mg/m^3	MU07000
306A	-	-	-	-	-	-
306AA	-	-	-	-	-	-
306B	-	10	-	-	-	DV50750
307	NEO	113	1,200 RBT	-	-	KI07000
308	CAR	113	2,500	-	USOS-Air TWA 1 mg/m^3 (skin)	KJ33250
309	CAR	75	-	LCL_o 1,000 ppm/45M	USOS-Air CL 15 ppm (skin)	KN08750
309AA	-	500	1,000	-	-	W065600
309AB	-	-	-	-	-	-
309AC	-	2,890	-	-	-	KN79600

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
309AD	-	-	-	-	-	-
309AE	-	-	-	-	-	-
309B	-	2,000	-	-	-	TF01750
310	-	500	-	-	-	DC78750
310A	-	-	-	-	-	-
311	-	LDL_o 1,500	-	-	-	BX29750
312	-	3,500	-	-	-	DG78750
313	-	410	-	-	USOS-Air CL 10 ppm	KI10500
314	-	750	-	-	-	VN84000
315	-	375	1,500	-	USOS-Air TWA 10 mg/m^3	AG68250
315ZC	-	666	280 SCU-MUS	-	-	AG89250
315AG	-	-	-	-	LDL_o 250 mg/kg IPR-MUS	AG71750
315AI	-	TDL_o 150	-	-	-	AG77000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
315AL	-	TDL_o 150	-	-	-	AG80500
315AU	-	TDL_o 150	-	-	-	AG85750
315AV	-	700	-	-	-	AG87500
316	-	700	800	-	-	ES91000
317	-	1,700	-	-	-	KK45500
319	-	730	-	-	USOS-Air TWA 15 mg/m^3	KK49000
320	-	800	1,400	-	-	UF10500
322	-	LDL_o 1,000	-	-	-	SK91000
322A	-	-	-	-	-	-
323	-	LDL_o 270	1,680 RBT	-	-	TB50750
323A	-	-	-	-	-	-
323B	-	-	-	-	-	-
323D	-	740	-	-	-	KN84000
323E	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	 Acute Dermal-LD_{50} (mg/kg)	 Inhalation-LD_{50} (mg/kg)	 Other	NIOSH-Toxic Substances List Cross-Reference No.
323F	-	-	-	-	-	-
323G	-	-	-	-	LD_{50} 5,000 mg/kg UNK-MAM	US79600
324	-	140	2,100	-	-	TY01750
324A	-	250	LDL_o 2,100 RBT	-	-	UC83100
325	-	560	-	-	-	UE49000
326	-	LDL_o 3,500	-	-	-	DG80500
326A	-	-	-	-	USOS-Air TWA 1,000 ppm	KI11000
326B	-	757	1,000	-	-	CV38500
327	-	-	-	-	-	-
327A	-	-	-	-	LD_{50} 14 mg/kg IPR-MUS	DD73500
328	-	56	75	-	USOS-Air TWA 1 mg/m^3 (skin)	TC03500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
328A	-	-	-	-	-	-
329	-	1,800	-	-	-	AS40250
329A	-	-	-	-	-	-
330	-	400	-	-	-	SK70000
331	-	-	-	-	-	-
331AA	-	-	-	-	-	-
331A	-	84	-	-	-	BP65600
331B	-	-	-	-	-	-
332	-	-	-	-	-	-
333	CAR	46	60	-	USOS-Air TWA 250 µg/m^3 (skin)	IO17500
333A	-	-	-	-	-	-
333B	-	-	-	-	-	-
333C	-	-	-	-	-	-
333D	-	5	-	-	-	TF05250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
333E	-	3	-	-	-	TF14000
334	-	885	-	-	-	XY73500
334B	-	2,050	-	-	-	TF14100
335	-	16	860	-	-	GN63000
335A	-	-	-	-	-	-
335B	-	61	-	-	-	TD57750
335BB	-	-	-	-	-	-
335C	-	3,000	2,000 RBT	-	-	SS94850
337	-	-	-	-	-	-
338	-	480	LDL_o 2,100 SKN-RAT	-	-	LQ77000
338A	-	-	-	-	LD_{50} 2,00 mg/kg IVN-RBT	ID59500
340	-	15	380	-	-	FB38500
340A	-	3.6	90	-	-	TD85750
341	-	LDL_o 2	6	-	TLV-Air TWA 100 µg/m^3 (skin)	TD92750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
342	-	76	455	-	TLV-Air TWA 100 $\mu g/m^3$ (skin)	TF33250
343	-	2	3	-	-	TF38500
343A	-	50	-	-	-	TF37500
343B	-	-	-	-	-	-
344	-	9	250	-	-	TD84000
344A	-	-	-	-	-	-
344AB	-	1,600	-	-	-	FB92100
344AC	-	82	-	-	-	TF56350
344B	-	8	100	-	-	TD82250
344C	-	-	-	-	-	-
345	-	3.5	11	-	-	TF57750
345A	-	67	-	-	-	GW42000
345B	-	26	-	-	-	TF51250
346	-	200	2,180 RBT	-	-	XS36750

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
347	-	-	-	-	-	-
348	-	-	-	-	-	-
349	-	-	-	-	LDL_o 180 mg/kg ORL-DOG	IH20000
349B	-	1,000	-	-	-	QL07000
350	-	-	-	-	-	-
350A	-	-	-	-	-	-
350B	-	1,600 IPR-RAT	-	-	-	UP79850
352	CAR	3,800	TDL_o 1,300 SCU	-	-	UR59500
352A	CAR	2,340	TDL_o 1,500 SCU	-	-	UR60000
352B	-	-	-	-	-	-
352C	-	-	-	-	-	-
353	-	2,500	-	-	-	VL12250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg	Other	
353AA	-	67	-	-	-	GW42000
353A	-	110	LDL_o 0.21	-	-	DI40250
353B	-	-	-	-	-	-
354	-	-	-	-	LDL_o 128 mg/kg IPR-MUS	VC57750
355	-	800	-	-	-	BO74800
355A	-	-	-	-	-	-
356	-	368	-	-	-	BO71750
356AA	-	6	3 SCU	360 mg/m^3/10M	-	TE50750
356A	-	200	-	-	-	FB98000
356B	-	90 IPR	-	-	-	TD36750
357	-	770	2,000 RBT	-	-	TE02500
358	-	147	353	-	-	TE17500
359	-	-	-	-	-	-
359A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
359B	-	60	15 IPR	-	-	CZ17500
359C	-	147	-	-	-	EZ91000
359D	-	-	-	-	-	-
359DD	-	-	-	-	-	-
359E	-	500	1,260 RBT	-	-	BX80500
360	-	30	275	-	-	FC01750
360A	-	250	-	-	-	FD12250
361	-	179	1,000	-	-	FC11400
362	-	1,000	-	-	-	RB89250
362A	-	375	-	-	-	TD61250
363	NEO	TDL_o 1,440	-	-	-	AH13500
364	-	-	-	-	-	-
364A	-	240	-	-	-	LQ80500
364B	-	1	300	-	-	FC10500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
365	-	800	-	-	-	AH15750
365A	-	-	-	-	-	-
366	-	47	100	-	-	TG14200
366A	-	4,200	3,500 SCU	-	USOS-Air TWA 10 ppm (skin)	LQ21000
366C	-	330	353	-	-	TE10500
366D	-	-	-	-	-	-
367	-	31	LDL_o 20 RBT	-	-	LZ94500
368	-	-	-	-	-	-
368A	-	-	-	-	-	-
368B	-	LDL_o 50	700	-	-	TF80500
368C	-	-	-	-	-	-
369	-	-	-	-	-	-
369A	-	15	68	-	-	TF94500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
370	-	7	48 RBT	-	-	TC50750
371	-	200	283	-	-	TE14000
371A	-	500 TRK	-	-	-	NI50750
372	-	9	67	-	TLV-Air TWA 200 $\mu g/m^3$ (skin)	TG01750
373	-	250	LDL_o 300	-	-	TG03500
374	-	16	300	-	USOS-Air TWA 200 $\mu g/m^3$ (skin)	TE19250
375	-	-	-	-	-	-
376	-	16	42	-	-	TC38500
377	-	21	112	-	-	TC43750
378	-	74	202	-	-	GQ50750
378A	-	7.5	118 RBT	-	-	TB49700
379	-	600	-	-	-	TE26250
379A	-	103	160 RBT	-	-	TF79000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
380	-	4,400 RBT	-	-	USOS-Air TWA 5 mg/m^3	TI15750
380A	-	-	-	-	-	-
380B	-	-	-	-	-	-
381	-	20	-	-	-	PV62100
381A	-	-	-	-	-	-
382	-	-	-	-	-	-
383	-	2,200	-	-	-	PD08750
385	-	400	-	-	-	TA07000
385A	-	1,100	-	-	-	ET01750
385B	-	89	-	-	-	YT15750
386	-	650	-	-	-	QE27050
387	-	-	-	-	-	-
388	-	-	-	-	LDL_o 4 mg/kg IPR-MUS	SL92750
388A	-	LDL_o 100	-	-	-	DA52500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
389C	-	1,070	130 RBT	-	-	CZ05250
390	-	25	200	-	USOS-Air TWA 200 µg/m^3 (skin)	GO96250
390A	-	LDL_o 30	LDL_o 20 SCU	-	-	GP10500
391	-	65	LDL_o 30 SCU-MUS	-	-	SK66500
391A	-	400	-	-	LDL_o 1,000 mg/kg SKN-GPG	SK70000
391B	-	-	-	-	-	-
391C	-	3,600	-	-	-	XU61250
391D	-	980	-	-	LD_{50} 23 mg/kg IVN-RAT	GQ57750
392	-	30	25 SCU	-	-	SL28000
392A	-	-	-	-	LD_{50} 108 mg/kg UNK-MAM	FF89500
392B	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
392C	-	-	-	-	LD_{50} 1,000 mg/kg ORL-DOG	XK94500
392DD	-	25	80	-	-	SJ98000
392DE	-	-	-	-	-	-
392DF	-	45	LDL_o 67	-	-	SK05250
293DG	-	-	-	-	-	-
392DH	-	-	-	-	-	-
392DI	-	-	-	-	-	-
392H	-	-	-	-	-	-
392I	-	1,900	-	-	-	WN05250
392J	-	90	1,660 MUS	-	-	FC19250
393	-	-	-	-	LD_{50} 240 mg/kg UNK-MAM	TD75250
394	-	0.9	-	-	LD_{50} 15 mg/kg ORL-CAT	NK56000
394A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
395	-	293	800 SCU-MUS	-	-	AB80500
396	-	3,500	-	-	-	AL98000
398	-	LDL_o 3,000	-	-	-	JJ78000
399	-	-	-	-	-	-
399A	-	-	-	-	-	-
399B	-	-	-	-	-	-
399C	-	-	-	-	-	-
399D	-	-	-	-	-	-
399DA	-	-	-	-	-	-
399E	-	-	-	-	-	-
400	-	-	-	-	-	-
401	-	1,500	-	-	-	QJ34400
401A	-	-	-	-	-	-
402	-	231	20 SCU	-	-	JM56900

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
402A	-	-	-	-	-	-
402B	-	-	-	-	-	-
403	-	-	-	-	-	-
404	-	-	-	-	-	-
405	-	1,800	-	-	-	PA22750
406	-	-	-	-	-	-
406A	-	-	-	-	-	-
406B	-	-	-	-	-	-
407	-	-	-	-	-	-
408	-	900 MUS	-	-	-	SN05250
408AA	-	-	-	-	-	-
408A	-	5,000 UNK-RAT	-	-	-	TB20500
408AB	-	-	-	-	LDL_o 100 mg/kg IPR-MUS	DL45500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
408B	-	-	-	-	-	-
409	-	-	-	-	-	-
410	-	437	-	-	-	YS89250
411	CAR	LDL_o 306	-	-	-	PC82250
411A	-	-	-	-	-	-
412	-	-	-	-	-	-
413	-	-	-	-	-	-
413A	-	-	-	-	-	-
413B	-	-	-	-	-	-
413C	-	2,300	-	-	-	DB66500
413D	-	-	-	-	-	-
413DA	-	-	-	-	-	-
413DB	-	-	-	-	-	-
413DC	-	-	-	-	-	-
413E	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
413EB	-	-	-	-	-	-
414	-	-	-	-	-	-
415	-	-	-	-	-	-
416	-	-	-	-	-	-
416A	-	-	-	-	-	-
416B	-	-	-	-	-	-
416C	-	400	-	-	-	BO31500
417	-	-	-	-	-	-
418	-	-	-	-	-	-
418A	-	-	-	-	LDL_o 13 mg/kg UNK-MUS	MF19250
418AA	-	-	-	-	-	-
419	-	566	-	-	-	MF17500
420	-	18	74	-	TLV-Air TWA 100 µg/m^3 (skin)	RB92750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
421	-	38	-	-	-	RN78750
421A	-	-	-	-	-	-
421AB	-	-	-	-	-	-
421B	-	-	-	-	-	-
421BA	-	-	-	-	-	-
421C	-	51	750	-	-	RN82250
421D	-	-	-	-	-	-
422	-	23	130	-	-	TF82250
423	-	3	15	-	USOS-Air TWA 10 µg/m^3 (skin)	IO15750
424	NEO	90	100 SKN-RBT	LCL_o 250 ppm/4H	USOS-Air TWA 5 ppm (skin)	TX49000
424A	-	-	-	-	-	-
425	-	1,120	-	-	-	UF14000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
425A	-	3,400	-	-	-	GN17750
425B	-	-	-	-	-	-
425C	-	-	-	-	-	-
425D	-	-	-	-	-	-
426	-	2,100	2,537 SCU-MUS	-	USOS-Air TWA 3 ppm	KJ57750
426A	-	-	-	-	LD_{50} 4,200 mg/kg UNK-MAM	SZ71000
426B	-	710	-	-	-	EZ72900
427	-	13	62	-	-	TE45500
427AA	-	34	60	-	-	TE40250
427A	-	-	-	-	-	-
427C	-	-	-	-	-	-
427CC	-	-	-	-	-	-
427D	-	800	-	-	-	VB82250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Toxicity Data Acute Dermal-LD_{50} (mg/kg)	Toxicity Data Inhalation-LD_{50} (mg/kg)	Toxicity Data Other	NIOSH-Toxic Substances List Cross-Reference No.
427E	-	3,800	-	-	-	GD98000
427EE	-	-	-	-	-	-
427F	-	-	-	-	-	-
428	-	2,000 MUS	-	-	-	XJ47250
429	-	4,930 RBT	5,000 SCU	LC_{50} 1,600 ppm	USOS-Air TWA 400 ppm	AH54250
430	-	LDL_o 220 MUS	8,285 SCU-MUS	-	USOS-Air TWA 1,000 ppm	KQ63000
430A	-	56 BDW	-	-	-	DG24500
430B	-	1,465	-	-	-	XY87500
431A	-	125	2,000	-	-	TE12250
431AB	-	-	-	-	-	See 188AC
431AC	-	1,550	-	-	-	UE75500
431AD	-	-	-	-	-	-
431B	-	1,500	-	-	-	GQ70000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD$_{50}$ (mg/kg)	Acute Dermal-LD$_{50}$ (mg/kg)	Inhalation-LD$_{50}$ (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
432A	-	3,160	-	-	-	EZ36750
434	CAR	700	-	LC$_{50}$ 500 ppm IHL-MAM	-	DD22750
434A	-	4,000	-	-	-	EZ75250
434AB	-	200	700	-	-	AI78750
434B	-	150	-	-	-	TE38500
435	-	1,630	1,460 RBT	LCL$_o$ 200 mg/m^3/3H	-	FA45500
436	-	-	-	-	-	KU53400
436A	-	3,000	-	-	-	LQ28000
436B	-	64	-	-	-	EG38500
437	-	0.8	730 RBT	-	USOS-Air TWA 10 ppm	KH85750
437A	-	150 IMS	-	-	-	KV38500
438	-	2,000	-	-	-	AH40250
438AA	-	2,000	-	-	-	AH43750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
438A	-	-	-	-	-	-
438B	-	-	-	-	-	-
438C	-	1,800	-	-	-	AH49000
438D	-	-	-	-	-	-
438E	-	-	-	-	-	-
438F	-	2,150	-	-	-	AH52500
439	-	140	300 RBT	LCL_o 400 ppm/2H	USOS-Air TWA 20 ppm	KH92750
440	-	725	-	-	USOS-Air TWA 100 ppm	KI01750
441	NEO	2,000 CAT	TDL_o 4 g/kg SKN-MUS	-	-	KW29750
441A	-	-	-	-	-	-
442	-	-	-	-	-	-
443	-	330	-	LC_{50} 1,462 ppm/4H	USOS-Air TWA 50 ppm	KX24500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances Li Cross-Referen No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
443A	-	1,850	-	LCL_o 8,000 ppm/4H	USOS-Air TWA 100 ppm	LQ84000
444	-	501	-	-	-	CM26250
445	-	2,400	-	-	-	MD26250
446	-	-	-	-	-	-
446A	-	LDL_o 2,300	-	-	-	TA04400
447	-	5,000 RBT	-	-	-	DH21900
447AB	-	-	-	-	-	-
447AC	-	-	-	-	-	-
447AD	-	-	-	-	-	-
447AE		LDL_o 29 ORL-CKN	-	-	USOS-Air TWA 10 $\mu g/m^3$	OV61250
447B	-	-	-	-	-	-
448	-	30	200	-	USOS-Air TWA 10 $\mu g/m^3$	OV98000
449	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
451	-	-	-	-	-	-
452	-	30	-	-	-	OW43750
453	-	100	-	-	-	OW38500
453A	-	8	73	-	-	TB36750
454	-	8	25	-	-	TB19250
454A	-	-	-	-	-	-
454B	-	3	147	-	-	TA59500
454BA	-	-	-	-	-	-
454D	-	-	-	-	-	-
455	-	47	100	-	-	TG14200
455A	-	38	500	LC_{50} 195 mg/m^3/4H	-	TF90500
455B	-	25	-	-	-	TE43750
456	-	180	-	-	-	TG16500
456AA	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
456A	-	15	64	-	-	TB07000
456B	-	480	LDL_o 2,100	-	-	LQ77000
456C	-	LDL_o 500	LDL_o 5,000 SCU	-	-	SJ43750
456D	-	35	1,460 RBT	-	-	TF76500
456EA	-	4,720	-	-	-	HE43750
456EB	-	-	-	-	-	-
456EC	-	-	-	-	-	-
456F	-	310	330	-	-	TF96250
457	-	-	-	-	-	-
458	-	4,000	-	-	USOS-Air TWA 15 mg/m^3	NO87500
459	-	900	-	-	TLV-Air TWA 1 mg/m^3	LJ91000
459A	-	-	-	-	-	-
459B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
459C	-	3,250	-	-	-	BR65000
460	-	-	-	-	-	-
460AA	-	-	-	-	LD_{50} 1,550 mg/kg UNK-RAT	XU51600
460A	-	89	-	-	-	YT15750
460B	-	2,600	-	-	-	XS98450
461	-	5.7	80	-	-	AC12250
462	-	-	0.28 SCU	-	TDL_o 2 mg/kg ORL-HMN	AH59500
462AA	-	-	-	-	-	-
462A	-	5	4	-	-	AH28000
463	-	-	-	-	LDL_o 200 mg/kg ORL-GPG	VV82250
464	-	-	-	-	TDL_o 500 mg/kg ORL-HAM	TI56850

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
465	NEO	800	420 SCU	LCL_o 250 ppm/4H	USOS-Air TWA 3 ppm	LP89250
465	-	-	-	-	-	-
465B	-	20	-	-	-	FC28000
465CC	-	-	-	-	-	-
465E	-	-	-	-	LD_{50} 200 mg/kg IPR-MUS	LS96250
466	-	127	LDL_o 500 SCU-RBT	LCL_o 153 ppm/4H	USOS-Air TWA 5 ppm (skin)	LT70000
466AA	-	700 UNK	-	-	-	GZ16400
466A	-	1,100	-	-	-	DD90100
467	-	-	-	-	-	-
468	-	2,380	2,560 RBT	LCL_o 5,000 ppm/4H	-	MA24500
469	-	7,750 GPG	-	-	-	MA80500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
470	-	1,950	-	-	-	MC52500
471	-	1,340	-	-	-	NJ38250
471AB	-	4,320	-	-	-	MC10750
471AC	-	-	-	-	-	-
471AD	-	-	-	-	-	-
471B	NEO	TDL_o 50	TDL_o 120 SCU-MUS	-	-	WG98000
472	-	-	-	-	-	-
472A	-	-	-	-	-	-
472B	-	-	-	-	-	-
473	-	-	-	-	-	-
474	-	40	195	-	USOS-Air TWA 500 $\mu g/m^3$ (skin)	PC07000
474A	-	-	-	-	-	-
474B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
474BA	-	-	-	-	-	-
474C	-	3,800	-	-	-	NJ37600
474D	-	-	-	-	-	-
474E	-	3,170	-	-	-	NJ33250
475	-	-	-	-	-	-
476	-	1,290	2,980	LC_{50} 360 ppm/4H	-	UC21000
477	-	3,500	-	-	-	DA29750
477A	-	-	-	-	-	-
478	-	113	-	-	TLV-Air TWA 10 ppb	GY12250
479	-	-	LDL_o 4,000 SCU-RBT	-	USOS-Air TWA 1 ppm (skin)	KI40250
480	-	150	-	-	-	OW34100
480AA	-	7	23	-	-	IO19250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
480A	-	155	-	-	-	OW42000
481	-	-	-	-	-	-
481A	-	-	-	-	-	-
481AB	-	-	-	-	-	-
481AC	-	-	-	-	-	-
481B	-	316	LDL_o 2,000 RBT	-	-	XY92750
481C	-	-	-	-	-	-
481D	-	-	-	-	-	-
481DE	-	-	-	-	-	-
481E	-	2,000 MUS	-	-	-	DU19250
481F	-	-	-	-	-	-
482	NEO	-	TDL_o 144 g/kg SCU	-	LD_{50} 9,200 mg/kg IVN-RAT	MN47250
482A	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
482AB	-	720	3,100 RBT	-	-	MQ40250
482AC	NEO	550	-	-	TDL_o 2,480 mg/kg IVG-MUS	VH15750
482B	-	-	-	-	-	-
482C	-	-	-	-	-	-
482D	-	-	-	-	TDL_o 20 mg/kg PAR-MUS	GM89250
483	-	3.7 MUS	LDL_o 3 SCU-MUS	LC_{50} 544 ppm/5M	USOS-Air TWA 10 ppm (skin)	MW68250
484	-	-	LDL_o 100 SCU-GPG	LC_{50} 1,276 ppm/1H	USOS-Air TWA 3 ppm	MW78750
485	-	LDL_o 200 GPG	LDL_o 250 SCU-GPG	-	-	VV82250
486	-	-	-	LC_{50} 4,700 ppm/30M	USOS-Air CL 5 ppm	MW96250
486A	-	-	-	-	-	-
486AB	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
486AC	-	110	LDL_o 0.21	-	-	DI40250
486B	-	-	-	-	-	-
486C	-	-	-	-	-	-
486D	-	3,800	-	-	-	NJ37600
486E	-	-	-	-	-	-
487	-	-	-	-	-	-
487A	-	-	-	-	-	-
487AB	-	-	-	-	-	-
487B	-	-	-	-	LD_{50} 337 mg/kg IPR-RAT	MB91850
487C	-	-	-	-	-	-
488	-	3,130	-	-	-	NJ28000
488A	CAR	TDL_o 572 MUS	-	-	-	KL28000
489	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
489A	-	-	-	-	-	-
489B	-	-	-	-	-	-
490	-	-	-	-	-	-
490A	-	-	-	-	-	-
491	-	-	-	-	-	-
491A	-	-	-	-	-	-
492	-	-	-	-	-	-
492A	-	-	-	-	-	-
492B	-	-	-	-	-	-
493	-	-	-	-	-	-
494B	-	-	-	-	-	-
494C	-	-	-	-	-	-
494D	-	-	-	-	-	-
495	-	1,900	-	-	-	TY73500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	 Acute Dermal-LD_{50} (mg/kg)	 Inhalation-LD_{50} (mg/kg)	 Other	NIOSH-Toxic Substances List Cross-Reference No.
495AA	-	70	-	-	-	QK57750
495A	-	-	-	-	-	-
495B	CAR	3,800	TDL_o 1,300 SCU	-	-	UR59500
496	-	535 MUS	450 MUS	-	-	UT96250
496AA	-	-	-	-	-	-
496A	-	17	-	-	-	GN76300
496B	-	25	600	-	-	FA19250
496C	-	-	-	-	-	-
497	-	-	-	-	-	-
498	-	-	-	-	-	-
498A	-	-	-	-	-	-
499	-	-	-	-	LDL_o 100 mg/kg IPR-MUS	NL52500
499A	-	-	-	-	-	-
499B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
501	-	-	-	-	USOS-Air CL 0.1 ppm	NN15750
501A	-	-	-	-	-	-
502	-	-	-	-	LDL_o 250 mg/kg IPR-MUS	KI77000
502A	-	-	-	-	-	-
503	-	0.2	-	-	-	AJ63000
503A	-	-	-	-	-	-
503AB	-	2,460	4,240 RBT	LCL_o 8,000 ppm/4H	USOS-Air TWA 100 ppm	NP96250
503B	-	280	500 RBT	-	-	NQ43750
504	-	3,400	-	-	-	YQ92750
505	-	-	-	-	-	-
505A	-	-	-	-	-	-
506	-	2,330	-	LDL_o 1,840 ppm/4H	USOS-Air TWA 25 ppm	GW77000
506A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
507	-	LDL_o 192 MUS	16 RBT	-	USOS-Air TWA 400 ppm	NT80500
508	-	83	-	-	TLV-Air TWA 500 μg/m^3	FC31500
509	-	LDL_o 192	16 RBT	-	USOS-Air TWA 400 ppm	NT80500
509A	-	2,400 MUS	-	-	-	XY98000
509B	-	LDL_o 1,630	-	-	-	XZ01750
510	NEO	1,000	-	-	-	FD91000
510AA	-	-	-	-	-	-
510A	NEO	1,200	-	-	-	FD80500
511	-	810	LDL_o 2,700 RBT	-	-	FI12250
511D	-	13	5.6	-	-	FA21000
511DA	-	-	-	-	-	-
511E	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
512	NEO	1,000	-	-	-	FD91000
512AA	-	-	-	-	-	-
512A	-	29	-	-	-	FB78750
512B	-	150 MUS	-	-	-	FC33500
512C	-	-	-	-	-	-
513	-	900	-	-	-	AJ83500
513AA	-	-	-	-	-	-
513A	-	-	-	-	-	-
513B	-	-	-	-	-	-
514	-	-	-	-	-	-
515	-	-	-	-	-	-
515A	-	-	-	-	-	-
515AA	-	2.5 MUS	-	-	-	QJ57750
516	-	-	-	-	-	-
516A	-	3,000	-	-	-	EY99800

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
517	-	-	-	-	LDL_o 800 mg/kg ITR-RAT	OA55000
517AA	-	-	-	-	-	-
517A	-	-	-	-	-	-
518	-	-	-	-	-	-
518A	-	-	-	-	-	-
519	-	-	-	-	-	-
519A	-	2,700	-	-	-	JR19250
519B	-	LDL_o 200	LDL_o 1,500	-	-	OF38500
520	-	230	-	-	-	NX52500
521	-	-	-	-	-	-
522	-	-	-	-	-	-
523	-	1,250	-	-	-	XK96250
523A	CAR	TDL_o 82	-	-	-	AI52500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
524	-	100	-	-	USOS-Air TWA 150 µg/m^3	CG09800
525	-	-	-	-	-	-
525AA	NEO	-	TDL_o 48 g/kg MUS	-	-	OG20250
525A	-	-	-	-	-	-
525B	-	42	-	-	-	TB17200
526	-	LDL_o 4,600	-	-	-	OS81000
527	CAR	88	500	-	USOS-Air TWA 500 µg/m^3 (skin)	GV49000
527A	-	-	-	-	-	-
528	-	3,300	-	-	-	YS91000
528A	-	-	-	-	-	-
528B	-	-	-	-	-	-
529	-	LDL_o 280	LDL_o 2,100 RBT	-	USOS-Air TWA 500 µg/m^3 as As	CG10500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
530	-	-	-	-	-	OM24700
530A	-	LDL_o 5,250	-	-	LDL_o 1,100 mg/kg IPR-RAT	FO01750
531	-	2,800	LDL_o 900 SCU	-	-	OM28000
532	-	200 GPG	LDL_o 400 SCU-GPG	-	-	VV85750
532A	-	-	-	-	-	-
533	-	-	-	-	-	-
534	-	-	-	-	LDL_o 1,750 mg/kg SCU-RBT	OM45000
534A	-	-	-	-	-	-
534B	-	159 RBT	-	-	USOS-Air TWA 1 mg/m^3 as Cu	GL69100
534C	-	LDL_o 75 RBT	-	-	-	BQ11800
535	-	599	-	-	USOS-Air TWA 15 mg/m^3 (skin)	WM84000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
537	-	LDL_o 1,600	-	-	-	ON71750
537A	-	-	-	-	-	-
539	CAR	TDL_o 64,000	-	-	-	OP07000
539AA	-	-	-	-	-	-
539A	-	-	-	-	-	-
539A	-	-	-	-	-	-
540	-	3,180	LDL_o 2,000 SCU	-	-	OT03500
541	-	3,000	-	-	-	DL64750
541A	-	-	-	-	-	-
541B	-	-	-	-	-	-
541C	-	3,968	-	-	-	DL68250
543	-	93	1,550	LCL_o 31 mg/m^3	-	TE22750
543A	-	76	-	-	-	AI85750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
544	-	37	14 SCU	LCL_o MUS 300 mg/m^3/10M	-	OV91000
544A	-	18	-	-	-	OW87500
545	-	210	-	-	-	OV87500
546	NEO	LDL_o 1,429 ORL-HMN	TDL_o 29 IVN-HMN	TCL_o 169 μg/m^3/40Y IHL-HMN	USOS-Air CL 1 mg/10 m^3	OV45500
546A	-	-	-	-	-	-
546B	-	-	-	-	-	-
546C	-	-	-	-	-	-
546D	-	-	-	-	-	-
547	-	1,120	-	LCL_o 1,000 ppm/4H	USOS-Air TWA 25 ppm	SB42000
547A	-	-	-	-	-	-
548	-	630	-	-	-	XF99000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
549	-	-	-	-	LDL_o 300 mg/kg IPR-MUS	UC64750
549AA	-	-	-	-	-	-
549B	-	20	25	-	-	TE21000
549C	-	17	-	-	-	AK29750
549CA	-	-	-	-	-	-
549D	-	91 MUS	82 SCU-MUS	-	-	DF43750
549DD	-	-	-	-	-	-
549E	-	57	720	-	-	TA75650
550	-	5,000	-	-	USOS-Air TWA 15 mg/m^3	KJ36750
551	-	2,460	1,340 RBT	LCL_o 2,000 ppm/4H	USOS-Air TWA 25 ppm (skin)	KL57750
551B	-	16	-	-	USOS-Air TWA 10 $\mu g/m^3$	OV63000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
551C	-	-	-	-	-	-
551D	-	LDL_o 4,900	-	-	USOS-Air TWA 100 ppm (skin)	JM15750
552	-	LDL_o 420 MUS	9,800 SCU-MUS	-	USOS-Air TWA 200 ppm	PC14000
553	-	-	-	-	-	-
554	-	LDL_o 5,000	-	-	-	QJ96300
555	-	-	TDL_o 8,000 ppm SKN-HMN	TCL_o 35 ppm IHL-HMN	USOS-Air CL 20 ppm (skin)	PA49000
555A	-	148	-	LCL_o 5,700 ppm/4H	-	EL91000
556A	-	-	-	-	-	-
557	-	-	-	LCL_o 3,000 ppm/4H	USOS-Air TWA 100 ppm	PA63000
557A	-	1,072	756 RBT	-	-	UE88400
557B	-	31	-	-	-	LL60700

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
557C	-	700	LDL_o 28 SCU-MUS	-	-	AG15750
557D	-	-	-	-	-	-
557E	-	800	-	-	-	AG22750
557K	-	800	-	-	-	AG26250
558	-	-	-	-	-	-
558A	-	700 MUS	-	-	-	ES83800
559	-	650	900 RBT	-	-	UE97500
559A	-	1,060	-	-	-	UF01750
559D	-	650 MUS	-	-	-	UF03500
559E	-	-	-	-	-	-
561	-	-	-	-	-	-
561A	-	4	4	LC_{50} 14 ppm/1H	USOS-Air TWA 400 µg/m^3	GQ52500
561B	-	1,250	-	-	-	JF73500
561C	-	460	-	-	-	JF75250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
562	-	778	-	-	-	BQ34100
563	-	2,690	-	-	-	SM01750
563A	-	-	-	-	-	-
564	-	860 MUS	-	-	-	SM03500
564A	-	-	-	-	-	-
564B	-	-	-	-	-	-
565	-	-	-	-	-	-
566	-	60	LDL_o 600	-	-	SM07000
566A	-	-	-	-	-	-
567	-	LDL_o 1,000 RBT	-	-	-	SO56000
568	-	2,136	6,460 SCU-MUS	-	USOS-Air TWA 500 ppm	PA80500
568A	-	-	-	-	-	-
568B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
568C	CAR	-	TDL_o 62 g/kg MUS	-	-	RK08950
569	-	3,400	-	LCL_o 2,000 ppm/4H	USOS-Air TWA 200 ppm	EL64750
570	-	1,620 RBT	-	-	USOS-Air TWA 100 ppm	LQ89250
572	-	6,000 RBT	-	-	-	DH24500
573	-	305	-	-	-	PA96250
573AA	-	-	-	-	-	-
573A	-	-	-	-	-	-
573B	-	-	-	-	-	-
573C	-	-	-	-	-	-
573D	-	20 IPR-MUS	-	-	USOS-Air TWA 10 $\mu g/m^3$	OW49000
573E	-	-	-	-	LD_{50} 15 mg/kg UNK-MAM	OW20000
573F	-	56	-	-	-	OW66500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
573G	-	-	-	-	-	-
573H	-	72	-	-	-	OW70000
573HA	-	-	-	-	-	-
573I	-	-	-	-	-	-
573J	-	-	-	-	-	-
573JA	-	-	-	-	-	-
573JB	-	-	-	-	-	-
573K	-	-	-	-	-	-
573L	-	2,140	-	-	-	PQ52000
573M	-	-	-	-	-	-
573N	-	LDL_o 2,000	-	-	-	TY89250
573O	-	-	-	-	-	-
573P	-	-	-	-	-	-
574	-	3,696	-	-	-	SA07000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
574AA	-	2,080	-	LCL_o 4,000 ppm/15M	USOS-Air TWA 100 ppm	SA92750
574A	-	62	-	-	-	FA24500
574B	-	-	-	-	-	-
575	-	257	-	-	-	DG77000
575AA	-	200	-	-	-	FA26250
575A	-	2,500	-	-	-	FD85750
576	-	1,100	500	-	-	FG14000
576A	-	1,000	-	-	-	BO90000
577	-	887	-	-	-	VO47250
577A	-	-	-	-	-	-
578	-	-	-	-	LD_{50} 2,000 mg/kg UNK-MAM	BY62000
578A	-	1,170	-	-	-	WZ07000
578AB	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
578B	-	60	350	-	-	FC57750
578C	-	-	-	-	-	-
579	-	-	-	-	-	-
579AA	-	-	-	-	-	-
579A	-	2,000	-	-	-	YS33250
579B	-	14	1,500	-	-	FC07000
579C	-	-	-	-	LD_{50} 5 g/kg UNK-MAM	XI26250
580	NEO	-	TDL_o 40 g/kg SKN-MUS	-	-	SE71750
580C	-	750	-	-	-	PA24500
580D	-	-	-	-	-	-
580E	-	-	-	-	-	-
581	-	-	-	-	-	-
581A	-	-	-	-	-	-
582	-	-	-	-	LD_{50} 50 mg/kg UNK-MAM	PA26250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
582A	-	-	-	-	LD_{50} 250 mg/kg IMS-RAT	WA19000
583	CAR	1,480	-	-	-	US63000
583A	-	2,300	-	-	-	AJ80500
584	-	1,050	500 RBT	-	USOS-Air TWA 20 ppm (skin)	QD64750
584AA	-	1,500	-	-	-	FA07900
584A	-	-	-	-	LD_{50} 2,000 mg/kg UNK-RAT	LU51600
585	-	395	-	-	-	FA68250
586	-	250	800	-	USOS-Air TWA 3 mg/m^3	TB94500
587	NEO	1,780	TDL_o 3,500 SCU	-	USOS-Air TWA 10 ppm	QJ05250
588	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
589	-	1,000	-	-	-	QJ08750
589A	-	-	-	-	-	-
589AB	-	-	-	-	-	-
589B	-	-	-	-	LDL_o 512 mg/kg IPR-MUS	QJ12250
589C	-	-	-	-	-	-
589D	-	-	-	-	-	-
589E	-	-	-	-	-	-
590	-	2,420	LDL_o 2,940 SCU	-	-	QL29750
591	-	-	-	-	-	-
591A	-	-	-	-	-	-
592	-	1,770	-	-	-	TH73500
593	-	-	-	-	-	-
594	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
595	-	2,750	LDL_o 668 SCU	-	-	QP38500
595A	-	-	-	-	LDL_o 285 mg/kg IPR-MUS	QP43750
596A	-	-	-	-	-	-
596AB	-	-	LDL_o 500 SCU-DOG	-	USOS-Air TWA 4.5 mg/m^3	QR96000
596B	-	-	-	-	-	-
597	-	53	140	-	USOS-Air TWA 500 µg/m^3 (skin)	QS52500
597A	-	55	285	-	-	QS96250
598	-	5,000 MUS	LDL_o 4,000 SCU-MUS	-	-	QT05250
598AA	-	940	850 RBT	-	-	US75250
598A	-	1,470	-	-	-	AJ01750
599	-	-	-	-	LD_{50} 500 mg/kg IPR-MUS	AJ07000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
600	-	LDL_o 700 RBT	LDL_o 600 RBT	-	USOS-Air TWA 1 ppm (skin)	DA64750
601	-	-	-	-	-	-
601AA	-	-	-	-	-	-
601A	-	-	-	-	-	-
601AB	-	-	-	-	-	-
601B	-	-	-	-	-	-
602	-	-	-	-	-	-
602A	NEO	-	TDL_o 230 SCU-MUS	-	-	SD95000
603	-	350	-	-	-	SM22750
603A	-	-	-	-	-	-
604	-	-	-	-	-	-
604AA	-	-	-	-	-	-
605	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
605A	-	2,100	-	-	-	KL96250
606	-	5.3	-	-	-	RB87500
607	-	1,470	-	-	-	YT45500
607A	-	-	-	-	-	-
608	-	-	-	-	-	-
609	-	4.8	5	-	-	PC12250
609A	-	-	-	-	-	-
610	-	5	15	-	-	UX59500
611	-	-	-	-	-	-
611A	-	1,790 MUS	-	-	-	RH65500
612	-	-	-	-	-	-
613	-	2,800	470 RBT	-	-	RB85750
613A	-	-	-	-	-	-
613B	-	-	-	-	-	-
613C	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
613D	-	-	-	-	LDL_o 25 mg/kg IPR-MUS	SM57750
614	-	-	-	-	-	-
614A	-	-	-	-	-	-
614B	-	368	-	-	-	BO71750
614C	-	-	-	-	-	-
614D	-	-	-	-	-	-
615	-	2,000	-	-	-	DA57750
616	-	2,090	-	-	-	BZ89250
616A	-	387	-	-	-	RI68250
617	-	-	-	-	-	-
618	-	-	-	-	LDL_o 1,000 mg/kg ORL-MAM	GE87500
618A	-	4,440	-	-	-	LE25300
618B	-	-	2,500 RBT	-	-	LY40600

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
618C	-	-	-	-	-	-
618D	-	-	-	-	-	-
618E	-	5,000	-	-	-	VL04450
618F	-	2,840	-	-	-	XP20000
619	NEO	-	TDL_o 3,120 SCU-RBT	-	-	RG22750
619A	-	-	-	-	-	-
620	-	-	-	-	-	-
621	-	-	-	-	-	-
621A	-	-	-	-	-	-
622	-	8 IVN-RBT	-	-	USOS-Air TWA 500 μg/m^3 as As	CG07000
623	-	-	-	LCL_o 707 ppm/7H	-	CZ45000
623A	-	-	-	-	-	-
624	-	2,000	-	-	-	DB52500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD$_{50}$ (mg/kg)	Acute Dermal-LD$_{50}$ (mg/kg)	Inhalation-LD$_{50}$ (mg/kg)	Other	
624A	-	-	-	-	-	-
625	-	-	-	-	USOS-Air TWA 1 mg/m^3	RO24500
625A	-	12 UNK	-	-	-	RP23500
625B	-	-	-	-	-	-
626	-	-	-	-	-	-
627	-	-	-	-	-	-
627A	-	2,000	-	-	-	RP49000
627B	-	-	-	-	-	-
628	-	4,800	LDL$_o$ 650 SCU-MUS	-	-	QI78750
631	-	1,400	-	-	-	WR57750
632	CAR	500	TDL$_o$ 142 SCU-MUS	-	USOS-Air TWA 75 ppm	CZ45500
632A	-	-	-	-	-	-
633	-	800	-	-	-	YM14000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
634	-	57	80	-	USOS-Air TWA 500 μg/m^3 (skin)	DW22750
635	-	141	-	-	-	DW20100
635A	-	-	-	-	-	-
637	-	2	7	LCL_o 10 mg/m^3/2H	USOS-Air TWA 110 μg/m^3 (skin)	TF45500
637A	-	LDL_o 4,000	-	-	-	UT47250
638	-	22	-	-	-	GL64750
639	-	-	-	-	-	-
639A	-	-	-	-	-	-
639B	-	-	LDL_o 700 SCU-RBT	LCL_o 4,238 ppm/2H	-	KI63000
640	CAR	1,650	TDL_o 576 MUS	-	-	DA66500
641	-	27	105	-	USOS-Air TWA 500 μg/m^3	SM63000
641A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
641B	-	227	72 SCU	-	-	SM66500
641C	-	-	-	-	-	-
641D	-	-	-	-	-	-
641E	-	-	-	-	-	-
642	-	-	-	-	-	-
642AA	-	-	-	TCL_o 130,000 ppm IHL-HMN	USOS-Air TWA 1,000 ppm	RZ94500
642A	-	-	-	LCL_o 2,000 ppm/4H	-	SA31500
642B	-	-	-	-	-	AF83000
642C	-	-	-	-	-	-
642D	-	663	-	-	-	XU83500
644	-	1,540	-	-	-	SD87500
645	-	-	-	-	-	-
645A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
645B	NEO	-	TDL_o 40 g/kg MUS	-	-	SE71750
646	-	-	-	-	USOS-Air TWA 500 ppm	SE75250
646A	-	-	-	-	-	-
646AB	-	-	-	-	USOS-Air TWA 500 ppm	SE75250
646B	-	-	-	-	-	-
647	-	-	-	-	-	-
647A	-	-	-	-	-	-
647B	-	-	-	-	-	-
648	-	-	-	14	-	CH63000
648B	-	-	-	-	LD_{50} 3,000 mg/kg UNK-MAM	FD90500
649	CAR	414	669	-	USOS-Air TWA 5 ppm (skin)	SJ33250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
650	-	-	-	-	-	-
652	-	5,000	-	-	TLV-Air TWA 5 mg/m^3	SN50750
652A	-	-	-	-	LD_{50} 200 mg/kg IPR-MUS	SP68250
653	-	-	-	-	-	-
654	-	3,500	-	-	-	GW07000
654A	-	238	-	-	-	DD71750
654B	-	250	-	-	-	TD28000
655	-	4,000	-	-	-	AJ82250
655B	-	-	-	-	-	-
655C	-	1,790	790 RBT	-	-	SG71750
655D	-	4,000	-	-	-	UF64880
655DA	-	-	-	-	-	-
655E	-	-	-	-	-	-
656	NEO	30	37 SCU-MUS	-	-	OV64750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
656A	-	-	-	-	-	-
656B	-	-	-	-	-	-
656C	-	-	-	-	-	-
656D	-	-	-	-	-	-
565E	-	60	47 SCU	-	-	OW14000
657	-	-	-	-	-	-
657A	-	-	-	-	-	-
657B	-	-	-	-	-	-
657C	-	-	-	-	-	-
657D	-	-	-	-	-	-
657E	-	-	-	-	-	-
657F	-	-	-	-	-	-
657G	-	-	-	-	-	-
657H	-	390	-	-	-	OW77000
657I	-	-	63 SCU	-	-	OW84000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
657J	-	-	-	-	-	-
657K	-	90	-	-	-	OW91000
657L	-	-	-	-	-	-
657M	-	-	-	-	-	-
657N	-	30	-	-	-	BT47250
657O	-	-	-	-	-	-
657P	-	50 UNK	-	-	-	OW97000
658	-	2,700	-	-	-	DV57750
658A	-	-	-	-	-	-
658B	-	-	-	-	-	-
658C	-	-	-	-	-	-
658D	-	-	-	-	-	-
658E	-	1,160	-	-	-	DV77000
658F	-	-	-	-	-	-
659	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
660	-	1	3	-	TLV-Air TWA 50 µg/m^3 (skin)	TD94500
660A	-	120	390	-	-	TD64750
661	-	17	125	-	-	TC28000
662	-	1,530	2,740	-	USOS-Air TWA 1 mg/m^3	TB63000
663	-	LDL_o 10 RBT	LDL_o 13 SCU-RBT	LDL_o 500 mg/m^3/10M MUS	USOS-Air TWA 100 µg/m^3	TH35000
663AA	-	3,750	-	-	TLV-Air TWA 10 mg/m^3	TJ75250
663AB	-	-	-	-	-	-
663AC	-	-	-	-	-	-
663AD	-	-	-	-	-	-
663B	-	15 MUS	3 SCU-RAT	-	-	TJ91000
664	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
665	-	-	-	-	-	-
666	-	-	-	-	-	-
667	-	-	-	-	-	-
668	-	4,900	-	-	-	TL40250
668A	-	-	-	-	-	-
669	-	4.4	-	-	-	DF49110
670	-	3,800 MUS	-	-	-	XS80500
671	-	280	-	-	USOS-Air TWA 100 µg/m^3	NK63000
671AA	-	-	-	-	-	-
671A	-	-	-	-	-	-
671B	-	-	-	-	-	-
672	-	-	-	-	-	-
672A	NEO	TDL_o 7,500	-	-	-	NZ33000
672B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
672C	-	-	-	-	-	-
673	-	504	-	-	-	CP29750
674	-	-	-	-	-	-
675	-	-	-	-	-	-
675A	-	-	-	-	-	-
675B	-	-	-	-	-	-
675C	-	-	-	-	-	-
675D	NEO	-	-	-	TDL_o 2,120 mg/kg IMP-RAT	TQ33250
675E	-	-	-	-	-	-
676	-	-	-	-	-	-
676A	-	-	-	-	-	-
676B	-	-	-	-	-	-
677	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
678	-	-	LDL_o 68 SCU-MUS	-	-	TR08750
678A	-	-	-	-	-	-
678B	-	-	-	-	-	-
680	-	419	-	-	-	TR52500
681	CAR	-	TDL_o 2,500 SCU	-	TDL_o 750 mg/kg IVN-RAT	TR81600
681AA	-	-	-	-	-	-
681A	-	-	-	-	-	-
682	-	-	-	-	-	-
682A	NEO	14	150	-	USOS-Air TWA 0.5 mg/m^3 as As	CG35000
682B	-	-	-	-	-	-
682C	-	-	-	-	LDL_o 150 mg/kg ORL-GPG	TS66500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
684	-	-	-	-	-	-
685	-	1,870	-	-	-	TS77500
686	-	LDL_o 2,430	-	-	-	TS80500
687	-	-	-	-	USOS-Air CL 100 $\mu g/m^3$ as CrO_3	GB31500
688	NEO	841 MUS	-	-	TDL_o 100 mg/kg IPR-MUS	GS68250
688A	-	10	9 SCU	-	USOS-Air TWA 5 mg/m^3 (skin)	TS87500
689	-	-	-	-	-	-
690	-	-	LDL_o 10 SCU-RBT	-	-	HX76800
691	-	-	-	-	LD50 350 mg/kg IPR-MUS	EZ61250
691A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	 Acute Dermal-LD_{50} (mg/kg)	 Inhalation-LD_{50} (mg/kg)	 Other	NIOSH-Toxic Substances List Cross-Reference No.
692	-	-	LDL_o 400 SCU-MUS	-	-	FG15750
692A	-	-	-	-	-	-
692B	-	-	-	-	-	-
693	-	365	-	-	TLV-Air TWA 2 mg/m^3	TT21000
693A	-	-	-	-	-	-
694	-	LDL_o 1,862 MUS	-	-	-	TT29750
694A	-	-	-	-	-	-
695	-	-	-	-	-	OW98500
696	-	-	-	-	-	-
696A	-	-	-	-	-	-
697	-	-	-	-	-	-
698	-	-	-	-	-	-
699	-	1,090	500 SCU-MUS	-	-	SD64750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
699A	-	-	-	-	-	-
700	-	-	-	-	-	-
701	-	-	-	-	-	-
701A	-	-	-	-	-	-
701B	-	-	-	-	-	-
702	-	-	-	-	LDL_o 3,000 mg/kg SCU-GPG	TT59000
702A	-	-	-	-	-	-
703	-	854	-	-	-	XL19250
703A	-	-	-	-	-	-
703B	-	-	-	-	-	-
704	-	-	-	-	-	-
704A	-	-	-	-	-	-
704AB	-	-	-	-	-	-
704B	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
704C	-	1,750	2,200 RBT	-	-	XY42000
704D	-	2,100	-	-	-	XY43900
704E	-	1,480	250	-	-	WT29000
704F	-	70	-	LCL_o 2,000 mg/m^3 MUS	USOS-Air TWA 1 ppm (skin)	UK50750
705	-	LDL_o 53	-	-	-	UK43750
705A	-	-	-	-	-	-
706	-	150	670 RBT	LCL_o 16 ppm/4H	-	UC92750
707	-	1,510	500 RBT	-	-	UE59500
708	-	2,360	-	-	-	UF91000
709	CAR	TDL_o 3,500	TDL_o 20 SCU	-	-	RQ73500
709A	-	1,870	3,230 SCU-MUS	LCL_o 4,000 ppm/4H	USOS-Air TWA 200 ppm	UH82250
710	-	1,020	-	-	-	EZ05250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
711	-	1,470	-	-	-	FA47250
712	-	1,900	-	LCL_o 2,000 ppm/4H	USOS-Air TWA 75 ppm	TX96250
713	-	-	-	-	TL_m 96 > 1,000	TY20000
713A	-	930	1,500 RBT	LCL_o 4,000 ppm/4H	USOS-Air TWA 100 ppm	TZ29750
714	-	-	-	-	LD_{50} 200 mg/kg IPR-MUS	DH28000
714A	-	-	-	-	-	-
714B	-	80	-	-	-	FC75250
714BA	-	-	-	-	-	-
714BB	-	1,170	1,926 RBT	-	-	AE11400
714C	-	2,330	-	-	-	UR61250
715	-	1,200	-	-	-	GZ07000 (Pyrethrin I)
715	-	1,200	-	-	LD_{50} 960 mg/kg UNK-MAM	GZ17500 (Pyrethrin II)

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				HIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
716	-	200	-	-	USOS-Air TWA 5 mg/m^3	UR42000
717	-	891	1,000 SCU	LC_{50} 4,000 ppm/4H	USOS-Air TWA 5 ppm	UR84000
718	-	-	-	-	-	-
718A	-	-	-	-	-	-
718AB	-	-	-	-	-	-
718B	-	-	-	-	-	-
718C	-	-	-	-	-	-
719	CAR	1,200	-	-	TDL_o 29 g/kg	VC42000
719A	-	-	-	-	-	-
719AA	-	-	-	-	-	-
719B	-	-	-	-	-	-
719C	NEO	130	TDL_o 2,000 mg/kg MUS	LCL_o 320 mg/m^3	USOS-Air TWA 0.1 ppm	DK26250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
720	-	1,800	-	-	-	FG31500
721	-	LDL_o 1,000	-	-	-	WP21000
722	-	200	-	-	-	VF73500
722A	-	-	-	-	-	-
723	-	301	LDL_o 340 SCU-MUS	-	-	VG96250
724	-	906	2,000	-	USOS-Air TWA 10 mg/m^3	TG05250
725	NEO	132	-	-	USOS-Air TWA 5 mg/m^3	DJ28000
727	-	-	-	-	-	-
728	-	LDL_o 25	-	-	-	YX59500
729	CAR	1,950	LDL_o 1,000 SCU-RBT	-	-	CY28000
730	-	-	-	-	-	-
731	-	891	LDL_o 700 SCU	-	-	VO05250

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
731A	-	LDL_o 3,000 MUS	LDL_o 900 SCU-MUS	-	-	VQ14000
731B	-	2,500	-	-	-	XY49800
732	-	-	-	LCL_o 33 mg/kg/8H	USOS-Air TWA 0.2 mg/m^3	VS77000
732A	-	138	-	-	USOS-Air TWA 0.2 mg/m^3	VS89250
733	-	-	-	-	-	-
733A	-	5,000	-	-	-	YT73500
734	-	3,160	-	-	-	VV73200
734A	-	3,160	-	-	-	VV73200
735	-	100 MUS	-	-	USOS-Air TWA 10 µg/m^3	VW36750
736	-	LDL_o 300 GPG	LDL_o 800 SCU-GPG	-	-	VW42000
737	-	50 MUS	-	-	USOS-Air TWA 15 µg/m^3	VW47250
738	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
739	-	650	-	-	-	UF82250
740	-	5,000	-	-	-	XY52500
741	-	-	-	-	-	-
741A	-	3,530	8,000 SCU-MUS	-	-	AJ43750
742	-	-	-	-	LD_{50} 193 mg/kg IPR-MUS	VZ18700
742A	-	-	-	-	-	-
742B	-	-	-	-	-	-
743	-	LDL_o 12 RBT	-	-	USOS-Air TWA 500 µg/m^3 as As	CG12250
744	-	-	-	-	LD_{50} 1.2 mg/kg IPR-MUS	CG34000
746	-	4,100	LDL_o 2,000 SCU-RBT	-	-	DH66500
746A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
747	-	4,220	-	-	-	VZ09500
747A	-	LDL_o 200 GPG	LDL_o 250 SCU-GPG	-	-	VY14000
748	-	-	-	-	-	-
749	-	-	-	-	LD_{50} 193 mg/kg IPR-MUS	VZ18700
750	-	-	-	-	LD_{50} 650 mg/kg IPR-RAT	VZ20000
751	-	2,660	-	-	-	VZ22750
751AA	-	-	-	-	-	-
751A	-	2,600	-	-	-	CH77000
751B	-	-	-	-	-	-
752	-	LDL_o 4,000	-	-	LD_{50} 117 mg/kg IPR-MUS	VZ40500
753	-	1,200	-	-	LD_{50} 596 mg/kg IPR-MUS	FO05250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
754	-	3,000	LDL_o 3,500 SCU	-	-	VZ47250
755	-	-	-	-	-	-
755A	-	76	-	-	-	AG14000
755B	-	320	-	-	-	AS64750
755C	-	750	-	-	-	DB50750
756	-	-	-	-	-	-
757	-	-	LDL_o 243 SCU-RBT	-	LD_{50} 32 mg/kg IPR-MUS	GB32200
757A	-	-	-	-	-	-
758	-	6.4	LDL_o 10 SCU-MUS	-	USOS-Air TWA 5 mg/m^3 (skin)	VZ75250
758A	-	3,860	-	-	-	UF12250
758B	-	570	-	-	-	UP82250
759	-	1,670	-	-	-	WA03500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
761	NEO	TDL_o 160 IPL	LDL_o 51 SCU-GPG	-	USOS-Air CL 100 μg/m^3 as CrO_3	HX77000
761A	-	60	-	-	LD_{50} 15 mg/kg IPR-RAT	CZ17500
762	-	1,000	-	-	-	FD35000
762A	-	-	-	-	-	
763	-	LDL_o 30	LDL_o 20 SCU	-	-	GP10500
764	-	1,900	-	-	-	WN05250
765	-	2,000 MUS	-	-	-	WA36750
766	-	63	66 SCU-MUS	-	-	OV84000
768	-	200	-	-	USOS-Air TWA 4.6 mg/m^3	WA96250
769	-	180	LDL_o 125 SCU	-	USOS-Air TWA 5.5 mg/m^3	WB03500
770	-	0.22	5 SCU	LD_{50} 300 mg/m^3/10M	USOS-Air TWA 50 μg/m^3 (skin)	AH91000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
771	-	125	LDL_o 500 SCU-GPG	-	USOS-Air TWA 4.1 mg/m^3	WB08750
772	-	-	-	-	LD_{50} 870 mg/kg IPR-MUS	OY36750
773	-	LDL_o 500 RBT	-	-	USOS-Air TWA 2 mg/m^3	WB49000
774	-	-	-	-	LD_{50} 650 mg/kg IPR-RAT	VZ20000
775	-	-	-	-	LDL_o 8 mg/kg IVN-RAT	OW45500
776	-	-	-	-	-	-
777	-	4,340	-	-	-	WB64750
778	-	-	-	-	LDL_o 600 mg/kg PAR-MUS	ZD70000
778A	-	-	-	-	LDL_o 400 mg/kg UNK-MUS	OF07000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
778B	-	-	-	-	-	-
779	-	1,288	-	-	-	WT10500
779A	-	1,280	-	-	-	VV92750
780	-	700	800 RBT	-	-	FC21000
780AA	-	-	-	-	-	-
780A	-	1,770	-	-	-	TH73510
781	-	LDL_o 200	-	-	-	WC56000
781A	-	1,100	-	-	-	MB84000
782	-	85	LDL_o 15 SCU	-	-	RA12250
782A	-	-	-	-	-	-
783	-	-	-	-	-	-
784	-	227	72 SCU	-	-	SM66500
784A	-	-	-	-	LD_{50} 538 mg/kg IPR-MUS	SC73500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
785	-	-	-	-	LD_{50} 226 mg/kg IPR-MUS	SE05250
785A	-	-	-	-	-	-
786A	-	-	-	-	-	-
787	-	1,160	-	-	-	DV77000
788	-	-	875 SCU-MUS	-	-	WD57750
789	-	-	-	-	-	-
790	-	-	1,640 RBT	-	-	UF75250
790A	-	-	-	-	-	-
790AA	-	-	-	-	-	-
790B	-	-	-	-	-	-
791	-	LDL_o 7 RBT	-	-	USOS-Air TWA 0.2 mg/m^3	VS66500
792	-	1,280	-	-	-	VV92750
793	-	-	-	-	LDL_o 4,470 mg/kg IVN-RBT	WE16500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
794	-	LDL_o 181 RBT	-	-	-	WE21500
795	-	2,660	-	-	-	VZ22750
796	-	-	-	-	-	-
796A	-	764	-	-	-	XL22750
796B	-	-	-	-	-	-
797	-	3,320	-	-	-	AJ91000
798	-	720	-	-	-	KM49000
799	-	-	-	-	LD_{50} 700 mg/kg IPR-MUS	YK49000
799A	-	-	-	-	-	-
800	-	-	-	-	-	-
801	CAR	-	TDL_o 2,600 SCU	-	-	WG21000
801A	-	4,920	-	-	-	WG21600
801B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
801C	-	-	-	-	-	-
802	-	-	-	-	USOS-Air TWA 500 ppm	WJ89250
804	-	-	520 SCU-MUS	-	-	WK43750
804A	-	-	-	-	LD_{50} 102 mg/kg IVN-MUS	WK49900
805	-	16	0.85 SCU-MUS	-	USOS-Air TWA 150 µg/m^3	WL22750
806	-	5	1.7 SCU	-	-	WL25500
807	-	LDL_o 2,700	-	-	-	WN24000
808A	-	8,000 DOG	-	-	-	AC84500
809	-	1.6	-	-	-	WO59500
809A	CAR	3,900	TDL_o 135 SCU	-	-	WO84000
809B	CAR	TDL_o 2,310 MUS	-	-	-	WP23600

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
809D	-	-	-	-	-	-
809E	-	-	-	-	-	-
810	-	-	-	-	-	-
811	-	-	-	-	-	-
812	-	-	-	-	-	WS42500
813	-	-	-	LCL_o 611 ppm/5H	USOS-Air TWA 5 ppm	WS45500
814	-	-	-	-	-	-
815	-	2,140	-	LCL_o 178 ppm/7H	USOS-Air TWA 1 mg/m^3	WS56000
816	-	-	-	-	-	WT48700
816A	-	LDL_o 100	-	-	USOS-Air TWA 5 ppm	WT50750
818	-	522	2,480 RBT	-	-	FD87500
819	CAR	5,000 RBT	TDL_o 4,450 SCU	-	-	WW50750
820	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
820A	-	115	55 SCU-MUS	-	USOS-Air TWA 0.5 mg/m^3 as Sb	CC68250
820B	-	-	-	-	-	-
821	-	1,000	1,370	-	TLV-Air TWA 10 mg/m^3	TF68900
821A	-	-	-	-	LD_{50} 5,000 mg/kg UNK-MAM	YQ93600
821AB	-	5	1 RBT	-	-	Data by American Cyanamid Company
821B	-	1,845	-	-	-	XY45500
821C	-	2,980	-	-	-	XY47250
822	CAR	200	-	-	-	WZ61250
823	-	4,300	-	-	-	WZ66000
824	-	4,800	LDL_o 650 SCU-MUS	-	-	QI78750
825	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
826	-	LDL_o 700 DOG	LDL_o 500 SCU-RBT	LCL_o 1,000 ppm/4H	USOS-Air TWA 5 ppm (skin)	KI85750
827	-	LDL_o 5,000 RBT	LDL_o 2,200 SCU-RBT	LCL_o 4,000 ppm/4H	USOS-Air TWA 100 ppm	KX38500
829	-	LDL_o 2,150	-	-	-	XB26250
830	-	-	-	-	-	-
830A	-	-	-	-	-	-
831	NEO	-	TDL_o 576 MUS	-	-	DC01750
832	-	140	210 SCU	-	-	SM91000
832A	-	-	-	-	-	-
832B	-	-	-	-	-	-
832C	-	-	-	-	-	-
832D	-	-	-	-	-	-
833	-	243	-	-	-	VV89000
833A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
833B	-	-	-	-	-	-
834	-	70	256 RBT	-	-	XN03500
835	-	-	-	-	-	-
835A	-	-	-	-	-	-
836	-	566	-	-	-	WR71000
837	-	5	8 SCU-MUS	-	USOS-Air TWA 200 µg/m^3 (skin)	XN43750
838	-	0.5	2.4	-	USOS-Air TWA 50 µg/m^3 (skin)	UX68250
838A	-	-	-	-	-	-
839	-	-	-	-	-	-
840	-	320	-	-	-	XI28000
841A	-	199	1,130 RBT	-	-	FC77000
842	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
842A	-	2,860	-	LCL_o 275 ppm/8H GPG	-	QK38500
842B	-	-	-	-	-	-
843	-	2	2	-	-	TD40250
844	-	-	-	-	-	-
845A	-	450	1,800	-	-	XN45500
846	-	-	-	-	LD_{50} 330 mg/kg IPR-MUS	AH50750
847	-	LDL_o 40 MUS	-	-	LD_{50} 59 mg/kg IPR-RAT	UX73500
848	-	-	-	-	-	-
849	-	16	-	-	-	XG66000
849A	-	3,100	-	-	-	DE07000
849B	-	-	-	-	-	-
850	-	1.3	-	-	LD_{50} 0.85 mg/kg IPR-RAT	GP33250

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
851	-	-	-	-	LDL_o 250 mg/kg IPR-MUS	SN03500
852	-	900 MUS	-	-	LDL_o 100 mg/kg IPR-MUS	SN05250
853	-	-	-	-	-	-
853A	-	-	-	-	-	-
853AB	-	-	-	-	-	-
853B	-	3,400 MUS	-	-	LD_{50} 790 mg/kg IPR-MUS	BA36750
854	-	-	-	-	-	-
855	NEO	20	-	-	-	YU28000
856	-	560	-	-	USOS-Air TWA 5 mg/m^3	JO14000
856A	-	980	-	-	-	XP22750
857	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
858	-	-	-	-	-	-
859	-	5,000	LDL_o 5,000 SCU	LCL_o 4,000 ppm/4H	USOS-Air TWA 200 ppm	XS52500
859A	-	-	-	-	-	-
859B	-	-	-	-	-	-
860	-	-	-	-	-	-
861	-	60	780	LDL_o 2,000 mg/m^3/2H MUS	USOS-Air TWA 500 $\mu g/m^3$ (skin)	XW52500
861A	-	-	-	-	-	-
862A	-	LDL_o 800	-	-	LDL_o 400 IPR-RAT	KM35000
863	-	410	110 SCU	-	-	VN89250
863A	-	178	-	-	-	TA29750
864	-	150	168	-	-	TG54250
865	-	910	615	-	-	TG56000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
867	-	99	-	-	USOS-Air TWA 100 µg/m^3 as Sn (skin)	WH57750
867AA	-	-	-	-	-	-
867A	-	-	-	-	-	-
867B	-	-	-	-	-	-
867C	-	-	-	-	-	-
867D	-	-	-	-	-	-
867E	-	-	-	-	-	-
867F	-	-	-	-	-	-
867G	-	-	-	-	-	-
867H	-	-	-	-	-	-
868	NEO	20	-	-	USOS-Air TWA 1 mg/m^3	CG08300
869	-	300	-	-	-	BZ50750
870	-	3,320	-	-	-	AJ78750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
870A	-	1,471	-	-	-	EZ85750
872	-	756	-	-	-	DC21000
873	-	650	1,500 SCU-MUS	-	-	DH77000
	-	1,644	-	-	-	DH84000
873A	-	3,075	-	-	-	XT85750
873B	-	-	-	-	-	-
874	-	-	-	-	-	-
874A	-	-	-	-	-	-
875	-	5,660 RBT	-	-	USOS-Air TWA 350 ppm	KJ292750
876	CAR	4,920	LDL_o 1,800 SCU-RBT	LCL_o 8,000 ppm/4H	USOS-Air TWA 100 ppm	KX45500
876AA	-	-	LDL_o 200 SCU	-	LD_{100} 400 mg/kg ORL-RAT	FM94500
877	-	490 MUS	-	-	-	XZ15750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
877B	-	-	-	LCL_o 10 ppm/6H	-	YC01750
878	-	-	-	-	USOS-Air TWA 1,000 ppm	PB61250
878A	-	-	-	-	-	-
879	-	820	2,260 SCU	-	LD_{50} 355 mg/kg IPR-RAT	SN14000
880	-	-	-	-	-	-
880A	-	-	-	-	-	-
880B	-	1,620	-	-	-	SN27500
880C	-	820	-	-	LD_{50} 276 mg/kg IPR-RAT	SN15750
881	-	300	TDL_o 0.45 SCU-MUS	-	USOS-Air TWA 10 mg/m^3	AJ84000
881A	-	-	-	-	-	-
881P	-	495	-	-	-	AJ84850

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
881T	-	495	-	-	-	AJ85750
881X	-	-	-	-	-	-
881Y	-	-	-	-	-	-
882	-	3,000	-	-	-	AJ87500
882A	-	-	-	-	-	-
882F	-	2,460	LDL_o 1,770 RBT	-	-	UF80500
882FA	-	1,100	-	-	-	UU09550
882G	-	80	-	-	-	UU77800
882H	-	-	-	-	-	-
883	-	750	-	-	-	XZ19250
883A	-	-	-	-	-	-
883AB	-	-	-	-	-	-
883B	-	-	-	-	-	-
883C	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
785	-	-	-	-	LD_{50} 226 mg/kg IPR-MUS	SE05250
785A	-	-	-	-	-	-
786A	-	-	-	-	-	-
787	-	1,160	-	-	-	DV77000
788	-	-	875 SCU-MUS	-	-	WD57750
789	-	-	-	-	-	-
790	-	-	1,640 RBT	-	-	UF75250
790A	-	-	-	-	-	-
790AA	-	-	-	-	-	-
790B	-	-	-	-	-	-
791	-	LDL_o 7 RBT	-	-	USOS-Air TWA 0.2 mg/m^3	VS66500
792	-	1,280	-	-	-	VV92750
793	-	-	-	-	LDL_o 4,470 mg/kg IVN-RBT	WE16500

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
794	-	LDL_o 181 RBT	-	-	-	WE21500
795	-	2,660	-	-	-	VZ22750
796	-	-	-	-	-	-
796A	-	764	-	-	-	XL22750
796B	-	-	-	-	-	-
797	-	3,320	-	-	-	AJ91000
798	-	720	-	-	-	KM49000
799	-	-	-	-	LD_{50} 700 mg/kg IPR-MUS	YK49000
799A	-	-	-	-	-	-
800	-	-	-	-	-	-
801	CAR	-	TDL_o 2,600 SCU	-	-	WG21000
801A	-	4,920	-	-	-	WG21600
801B	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
801C	-	-	-	-	-	-
802	-	-	-	-	USOS-Air TWA 500 ppm	WJ89250
804	-	-	520 SCU-MUS	-	-	WK43750
804A	-	-	-	-	LD_{50} 102 mg/kg IVN-MUS	WK49900
805	-	16	0.85 SCU-MUS	-	USOS-Air TWA 150 $\mu g/m^3$	WL22750
806	-	5	1.7 SCU	-	-	WL25500
807	-	LDL_o 2,700	-	-	-	WN24000
808A	-	8,000 DOG	-	-	-	AC84500
809	-	1.6	-	-	-	WO59500
809A	CAR	3,900	TDL_o 135 SCU	-	-	WO84000
809B	CAR	TDL_o 2,310 MUS	-	-	-	WF23600

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
809D	-	-	-	-	-	-
809E	-	-	-	-	-	-
810	-	-	-	-	-	-
811	-	-	-	-	-	-
812	-	-	-	-	-	WS42500
813	-	-	-	LCL_o 611 ppm/5H	USOS-Air TWA 5 ppm	WS45500
814	-	-	-	-	-	-
815	-	2,140	-	LCL_o 178 ppm/7H	USOS-Air TWA 1 mg/m^3	WS56000
816	-	-	-	-	-	WT48700
816A	-	LDL_o 100	-	-	USOS-Air TWA 5 ppm	WT50750
818	-	522	2,480 RBT	-	-	FD87500
819	CAR	5,000 RBT	TDL_o 4,450 SCU	-	-	WW50750
820	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
820A	-	115	55 SCU-MUS	-	USOS-Air TWA 0.5 mg/m^3 as Sb	CC68250
820B	-	-	-	-	-	-
821	-	1,000	1,370	-	TLV-Air TWA 10 mg/m^3	TF68900
821A	-	-	-	-	LD_{50} 5,000 mg/kg UNK-MAM	YQ93600
821AB	-	5	1 RBT	-	-	Data by American Cyanamid Company
821B	-	1,845	-	-	-	XY45500
821C	-	2,980	-	-	-	XY47250
822	CAR	200	-	-	-	WZ61250
823	-	4,300	-	-	-	WZ66000
824	-	4,800	LDL_o 650 SCU-MUS	-	-	QI78750
825	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
826	-	LDL_o 700 DOG	LDL_o 500 SCU-RBT	LCL_o 1,000 ppm/4H	USOS-Air TWA 5 ppm (skin)	KI85750
827	-	LDL_o 5,000 RBT	LDL_o 2,200 SCU-RBT	LCL_o 4,000 ppm/4H	USOS-Air TWA 100 ppm	KX38500
829	-	LDL_o 2,150	-	-	-	XB26250
830	-	-	-	-	-	-
830A	-	-	-	-	-	-
831	NEO	-	TDL_o 576 MUS	-	-	DC01750
832	-	140	210 SCU	-	-	SM91000
832A	-	-	-	-	-	-
832B	-	-	-	-	-	-
832C	-	-	-	-	-	-
832D	-	-	-	-	-	-
833	-	243	-	-	-	VV89000
833A	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
833B	-	-	-	-	-	-
834	-	70	256 RBT	-	-	XN03500
835	-	-	-	-	-	-
835A	-	-	-	-	-	-
836	-	566	-	-	-	WR71000
837	-	5	8 SCU-MUS	-	USOS-Air TWA 200 µg/m^3 (skin)	XN43750
838	-	0.5	2.4	-	USOS-Air TWA 50 µg/m^3 (skin)	UX68250
838A	-	-	-	-	-	-
839	-	-	-	-	-	-
840	-	320	-	-	-	XI28000
841A	-	199	1,130 RBT	-	-	FC77000
842	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
842A	-	2,860	-	LCL_o 275 ppm/8H GPG	-	QK38500
842B	-	-	-	-	-	-
843	-	2	2	-	-	TD40250
844	-	-	-	-	-	-
845A	-	450	1,800	-	-	XN45500
846	-	-	-	-	LD_{50} 330 mg/kg IPR-MUS	AH50750
847	-	LDL_o 40 MUS	-	-	LD_{50} 59 mg/kg IPR-RAT	UX73500
848	-	-	-	-	-	-
849	-	16	-	-	-	XG66000
849A	-	3,100	-	-	-	DE07000
849B	-	-	-	-	-	-
850	-	1.3	-	-	LD_{50} 0.85 mg/kg IPR-RAT	GP33250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
851	-	-	-	-	LDL_o 250 mg/kg IPR-MUS	SN03500
852	-	900 MUS	-	-	LDL_o 100 mg/kg IPR-MUS	SN05250
853	-	-	-	-	-	-
853A	-	-	-	-	-	-
853AB	-	-	-	-	-	-
853B	-	3,400 MUS	-	-	LD_{50} 790 mg/kg IPR-MUS	BA36750
854	-	-	-	-	-	-
855	NEO	20	-	-	-	YU28000
856	-	560	-	-	USOS-Air TWA 5 mg/m^3	J014000
856A	-	980	-	-	-	XP22750
857	-	-	-	-	-	-

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
858	-	-	-	-	-	-
859	-	5,000	LDL_o 5,000 SCU	LCL_o 4,000 ppm/4H	USOS-Air TWA 200 ppm	XS52500
859A	-	-	-	-	-	-
859B	-	-	-	-	-	-
860	-	-	-	-	-	-
861	-	60	780	LDL_o 2,000 mg/m^3/2H MUS	USOS-Air TWA 500 $\mu g/m^3$ (skin)	XW52500
861A	-	-	-	-	-	-
862A	-	LDL_o 800	-	-	LDL_o 400 IPR-RAT	KM35000
863	-	410	110 SCU	-	-	VN89250
863A	-	178	-	-	-	TA29750
864	-	150	168	-	-	TG54250
865	-	910	615	-	-	TG56000

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
867	-	99	-	-	USOS-Air TWA 100 μg/m^3 as Sn (skin)	WH57750
867AA	-	-	-	-	-	-
867A	-	-	-	-	-	-
867B	-	-	-	-	-	-
867C	-	-	-	-	-	-
867D	-	-	-	-	-	-
867E	-	-	-	-	-	-
867F	-	-	-	-	-	-
867G	-	-	-	-	-	-
867H	-	-	-	-	-	-
868	NEO	20	-	-	USOS-Air TWA 1 mg/m^3	CG08300
869	-	300	-	-	-	BZ50750
870	-	3,320	-	-	-	AJ78750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
870A	-	1,471	-	-	-	EZ85750
872	-	756	-	-	-	DC21000
873	-	650	1,500 SCU-MUS	-	-	DH77000
	-	1,644	-	-	-	DH84000
873A	-	3,075	-	-	-	XT85750
873B	-	-	-	-	-	-
874	-	-	-	-	-	-
874A	-	-	-	-	-	-
875	-	5,660 RBT	-	-	USOS-Air TWA 350 ppm	KJ292750
876	CAR	4,920	LDL_o 1,800 SCU-RBT	LCL_o 8,000 ppm/4H	USOS-Air TWA 100 ppm	KX45500
876AA	-	-	LDL_o 200 SCU	-	LD_{100} 400 mg/kg ORL-RAT	FM94500
877	-	490 MUS	-	-	-	XZ15750

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
877B	-	-	-	LCL_o 10 ppm/6H	-	YC01750
878	-	-	-	-	USOS-Air TWA 1,000 ppm	PB61250
878A	-	-	-	-	-	-
879	-	820	2,260 SCU	-	LD_{50} 355 mg/kg IPR-RAT	SN14000
880	-	-	-	-	-	-
880A	-	-	-	-	-	-
880B	-	1,620	-	-	-	SN27500
880C	-	820	-	-	LD_{50} 276 mg/kg IPR-RAT	SN15750
881	-	300	TDL_o 0.45 SCU-MUS	-	USOS-Air TWA 10 mg/m^3	AJ84000
881A	-	-	-	-	-	-
881P	-	495	-	-	-	AJ84850

Caswell Accession No.	Suspected Carcinogen	Toxicity Data Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
881T	-	495	-	-	-	AJ85750
881X	-	-	-	-	-	-
881Y	-	-	-	-	-	-
882	-	3,000	-	-	-	AJ87500
882A	-	-	-	-	-	-
882F	-	2,460	LDL_o 1,770 RBT	-	-	UF80500
882FA	-	1,100	-	-	-	UU09550
882G	-	80	-	-	-	UU77800
882H	-	-	-	-	-	-
883	-	750	-	-	-	XZ19250
883A	-	-	-	-	-	-
883AB	-	-	-	-	-	-
883B	-	-	-	-	-	-
883C	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data: Acute Oral-LD_{50} (mg/kg)	Toxicity Data: Acute Dermal-LD_{50} (mg/kg)	Toxicity Data: Inhalation-LD_{50} (mg/kg)	Toxicity Data: Other	NIOSH-Toxic Substances List Cross-Reference No.
884	-	3,000	-	-	USOS-Air TWA 0.1 mg/m^3	TD03500
884AA	-	-	-	-	-	-
884A	-	190	-	-	USOS-Air TWA 100 $\mu g/m^3$ as Sn (skin)	WH87500
884B	-	-	-	-	-	-
885	-	594	-	-	-	XY54250
886	-	8,000	-	-	-	KL92750
888	-	-	9,739 SCU-MUS	-	-	YE45500
888A	-	316	LDL_o 2,000 RBT	-	-	XY92750
888B	-	-	-	-	LDL_o 40 mg/kg IPR-RAT	SM52500
889	-	500	-	-	-	XU92750
890AA	-	-	-	-	-	-
890A	-	813	-	-	-	DH92750

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
890B	-	-	-	-	-	-
891	-	1,080	-	-	-	UB87500
892	-	-	-	-	-	-
892A	-	-	-	-	-	-
893	-	LDL_o 2,000	-	-	-	SA14000
893A	-	208	-	-	-	FC82250
894	-	375	-	-	-	YJ47250
896	-	-	-	-	-	-
896A	-	-	-	-	-	-
896B	-	-	-	-	-	-
896C	-	125	44 SCU-MUS	-	USOS-Air TWA 100 $\mu g/m^3$ as Sn (skin)	WH66500
896D	-	-	-	-	-	-
896E	-	46	-	-	USOS-Air TWA 100 $\mu g/m^3$ as Sn (skin)	WH-85750

		Toxicity Data				
Caswell Accession No.	Suspected Carcinogen	Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	NIOSH-Toxic Substances List Cross-Reference No.
896F	-	-	-	-	-	-
896G	-	-	-	-	-	-
897	-	850	-	-	-	KK47250
898	-	-	-	-	-	-
898A	-	1,400	-	-	-	QF22750
899	-	-	-	-	-	-
900	-	-	-	-	TCL_o 75 ppm IHL-HMN	YO84000
900A	-	-	-	-	LDL_o 20 mg/kg IPR-RAT	YP29750
901	-	2,500	-	-	-	YQ29750
902	-	-	LDL_o 3,000 SCU-RBT	-	-	YR62500
902A	-	-	-	-	-	-
903	-	3	-	-	USOS-Air TWA 0.1 mg/m^3	GN45500
903A	-	700 MUS	-	-	-	GN47250

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
904	-	-	-	-	-	-
905	-	-	-	-	-	-
906	-	4,300	-	-	NIOSH TWA 100 ppm	ZE21000
907	-	-	-	-	-	-
907AA	CAR	3,200	1,040	-	-	ZE65000
907A	-	-	-	-	LDL_o 500 mg/kg IPR-MUS	ZE50750
908	-	-	-	-	-	-
909	-	-	-	-	-	-
909A	-	-	-	-	-	-
910	-	-	-	-	LDL_o 30 mg/kg IVN-RAT	ZH14000
911	-	-	-	-	-	-
912	-	-	-	-	-	-
913	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
913A	-	-	-	-	-	-
914	-	LDL_o 100	-	-	-	ZH36750
915	-	-	-	-	-	-
916	-	-	-	-	-	-
917	-	540	-	-	-	DL70000
918	-	630	-	-	-	ZH43500
919	-	4,920	-	-	-	QK92750
920	-	-	-	-	USOS-Air TWA 5 mg/m^3	ZH48100
921	-	-	-	-	-	-
921A	-	-	-	-	-	-
922	-	40	-	-	-	ZH49000
922A	-	-	-	-	-	-
923	-	309	-	-	-	UT92750
924	-	-	-	-	-	-

Caswell Accession No.	Suspected Carcinogen	Toxicity Data				NIOSH-Toxic Substances List Cross-Reference No.
		Acute Oral-LD_{50} (mg/kg)	Acute Dermal-LD_{50} (mg/kg)	Inhalation-LD_{50} (mg/kg)	Other	
925	-	-	-	-	-	-
926	-	-	-	-	-	-
927	NEO	-	TDL_o 6.2 SCU-RBT	-	LD_{50} 40 mg/kg IPR-RAT	ZH52600
927A	-	-	-	-	-	-
928	-	-	-	-	-	-
929	-	1,000	-	-	-	ZH56000
930	CAR	TDL_o 54 g/kg	-	-	TDL_o 160 mg/kg IPR-MUS	ZH33250
931	CAR	1,400	-	-	-	ZH05250
931A	-	1,400	-	-	-	ZH16000
932	-	600	-	-	TLV-Air TWA 5 mg/m^3	XS42000

APPENDIX D

TABULATION OF AVAILABLE EMISSIONS DATA FOR THE PESTICIDES INDUSTRY

Table D-1. AIR EMISSION POLLUTANTS GENERATED BY PESTICIDE MANUFACTURERS

Pesticide manufactured	Type of pollutant	lb Pollutant/lb A.I.	lb Pollutant/unit time
Methyl parathion[a]	SO_2 (gas)	0.41	1,550 lb/hr
MSMA[b]	As_2O_3 (particulate)	3×10^{-11}	6.44×10^{-8} lb/hr
Trifluralin[c]	Nitrate (particulate)	--	1 lb/hr
	Sulfate (particulate)	--	1 lb/hr
	Chloride (particulate)	--	1 lb/hr
	SO_2 (gas)	--	3 lb/hr
	SO_3 (gas)	--	1 lb/hr
	HF (gas)	--	1 lb/hr
	HCl (vapor)	--	10 lb/hr
	NO_x (gas)	--	3 lb/hr
PCP[d]	PCP (particulate)	5.5×10^{-4}	--
	Na - PCP (particulate)	2.2×10^{-3}	--
	Phenol (vapor)	1.0×10^{-3}	--
Captan[e]	Captan (particulate)	--	~ 4 lb/day
DDT[f]	DDT (particulate)	--	~ 2.5 lb/hr

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[a] Ifeadi (1975); Emissions calculated by author.

[b] Ibid.; Emissions estimated by Diamond Shamrock Chemical Company, Greens Bayou, Texas.

[c] Ibid.; Emissions measured by Eli Lilly Company at their Lafayette, Indiana Plant.

[d] Ibid.; PCP emission reported by Reichhold Chemical, Inc., Tacoma, Washington; Phenol and Na-PCP reported by Monsanto Industrial Chemicals Company, Sauget, Illinois.

[e] Lawless, et al. (1972); Captan emission reported by Calhio Chemical (a Stauffer-Chevron Subsidiary, Perry, Ohio).

[f] F. Dryden, Head, Technical Services Department, County Sanitation District of Los Angeles County, June 1976.

Table D-2. RAW WASTEWATER CHARACTERISTICS OF ORGANIC PESTICIDE MANUFACTURERS

	Wastewater characteristics (given in mg/ℓ)									
Pesticides(s)	pH	COD	BOD_5	Total solids	Suspended solids	Chlorides	Sulfates	Phosphates	Organic nitrogen	Pesticides and other wastes
Chlorinated pesticides[a]	0.5	3,600	2,000	62,000	10	50,000	8,000	--	--	Phenol and cresol: 10 ppm; chlorophenols and chlorocresols: 100 ppm; chlorophenoxyacetic acids: 100 ppm; alcohols: 1,000 ppm.
Carbamates[b]	7-10	10,000	Nil	40,000	Nil	100	20,000	Nil	500	Sodium: 8,000 ppm. Carbamates: Nil.
Parathion and methyl parathion[b]	2	3,000	700	27,000	--	7,000	3,000	250	20	Sodium: 6,000 ppm. Parathion: 20 ppm.
Diolefin-based chlorinated hydrocarbons[b]	2	500	50	1,000	100	High	--	--	--	Endrin: 100-300 ppb.
2,4,5-T; 2,4-D; MCPA[b]	0.5	8,300	6,300	104,000	2,500	52,000	--	Low	Low	2,4-D: Up to 3,000 ppm. 2,4-D: 130 ppm is typical.
Carbaryl[c]	--	--	--	--	--	--	--	--	--	Carbaryl: 0.1-1.0 ppm.
Chlordane[c]	--	--	--	--	--	--	--	--	--	Chlordane: 400 ppm. Sodium Hydroxide: 20,000 ppm.
MSMA[c]	--	--	--	--	--	--	--	--	--	Arsenic: 0.7-0.8 ppm.
Creosote[c]	--	--	--	--	--	--	--	--	--	Phenolic materials: 800-900 ppm.
Maneb	--	--	--	--	--	--	--	--	--	Sodium sulfate, manganese sulfate, and sodium trithiocarbamates combined: 9 lb/13 lb maneb product.
Endrin[d]	3-4	--	--	--	500-800	--	--	--	--	Endrin: 100-1,500 ppb; 700 ppb avg; carbon tetrachloride: 400 ppm; hexachloronorbornadiene: 30-50 ppb; heptachloronorbornene: 30-50 ppb.
Toxaphene[e]	3-5	--	--	--	--	--	--	--	--	Toxaphene: < 6 to 2,200 ppb.
Atrazine[f]	6.0-8.5	420	60	--	120	--	--	--	6.6	Atrazine: 36 ppm

			Wastewater characteristics[g] (given in mg/ℓ)											
							Total solids							
Pesticide[h]	Data type[i]	Wastewater flow (gal/1,000 lb product)	COD	BOD_5	TOC	OIL	Suspended[j]	Dissolved	Phenol	Total phosphorus	Chloride	NH_3-N	Total Kjeldahl nitrogen	Metal
Halogenated														
A	W	2,500	810	120	550	3	48	1,550	0.5	--	--	--	--	--
B	H	1,200	16,000	8,500	--	--	--	3,580	0.5	--	--	--	--	--
B	W	1,200	14,400	3,300	8,000	4,300	100	115,000	200.0	--	--	--	--	--
C	H	48,000	--	--	--	--	10	--	--	--	--	--	--	--
D	H	10,400	400	--	--	--	450	--	--	--	--	--	--	--
E	H	48,000	--	--	--	--	198	--	--	--	--	--	--	--
F	W	17,300	--	--	--	--	--	--	--	--	--	--	--	--
G	W	37,800	2,490	1,800	603	6	10	733	0.03	--	--	--	--	--
Organophosphorus														
H		12,900	3,110	--	--	--	--	7,130	--	51	2,260	--	--	--
I		989	40,200	--	--	--	--	210,000	--	6,900	147,000	--	--	--
J		7,200	3,150	--	--	--	--	9,420	--	304	6,500	--	--	--
K	H	6,680	8,910	--	--	--	--	49,800	--	770	33,000	5,300	--	--
L		1,430	3,850	--	--	--	--	58,500	--	1,170	44,000	20,200	--	--
M		7,440	3,100	--	--	--	--	16,600	--	115	5,700	--	--	--
N		900	42,000	--	--	--	--	125,000	--	4,260	75,000	--	--	--
O		6,530	3,150	--	--	--	---	19,250	--	1,930	700	2,200	--	--

Table D-2 (continued)

Pesticide[h]	Data type[i]	Wastewater flow (gal/1,000 lb product)	Wastewater characteristics[g] (given in mg/ℓ)											
			COD	BOD_5	TOC	Oil	Total solids: Suspended[j]	Total solids: Dissolved	Phenol	Total phosphorus	Chloride	NH_3-N	Total Kjeldahl nitrogen	Metal
P	H	5,950	2,160	--	--	--	--	--	340	--	--	--	--	--
Q	H	5,140	3,600	--	--	--	--	--	255	--	--	--	--	--
R	H	5,150	4,100	--	1,700	--	--	19,000	0.3	210	6,900	--	--	--
S	H	333	19,700	540	--	--	--	86,000	--	19,000	--	--	--	--
T	H	1,530	6,100	--	--	--	--	--	--	--	--	--	--	--
U	H	3,760	--	--	--	--	--	--	--	--	--	--	--	--
V	H	640	--	--	--	--	--	--	--	--	--	--	--	--
W	H	179	--	--	--	--	--	--	--	--	--	--	--	--
X	H	2,530	--	--	--	--	--	--	--	--	--	--	--	--
Y	H	8,380	--	--	--	--	--	--	--	--	--	--	--	--
Z	W	1,780	335	135	108	10	73	41,500	0.6	2	--	2	--	--
AA	W	2,400	15,600	1,350	3,850	20	55	54,000	0.5	250	74,000	850	13	--
BB	W	5,510	4,240	955	934	59	15	14,800	11	610	--	630	9,400	--
S	W	333	12,500	--	6,830	7,200	36	79,000	36	2,150	--	250	--	--
Organo-nitrogen														
CC	H	10,200	4,740	--	--	--	--	44,300	--	--	13,700	318	--	--
DD	H	5,180	1,480	--	--	--	--	6,400	--	--	4,400	--	--	--
EE	H	5,400	--	820	--	--	--	19,900	--	178	18,800	--	--	--
FF	H	5,700	--	840	--	--	--	36,700	--	190	25,300	--	--	--
GG	H	1,200	800	300	--	--	--	20,000	--	--	450	13	--	--
HH	H	670	--	--	--	--	--	--	--	--	--	--	--	--
II	H	4,300	6,030	--	--	--	--	--	--	--	6,600	2,100	--	--
JJ		6,000	3,900	--	--	--	--	--	--	--	2,500	288	--	--
KK		1,210	14,300	--	--	--	--	--	--	--	23,000	1,500	--	--
LL		500	7,150	--	--	--	--	--	--	--	--	--	--	--
MM		2,400	2,650	--	--	--	--	--	--	--	3,900	80	--	--
NN	H	6,200	770	350	--	--	--	--	--	--	--	--	--	--
OO		4,000	1,800	750	--	--	--	--	--	--	--	--	--	--
PP		8,250	1,680	495	--	--	--	--	--	--	--	--	--	--
QQ		5,250	15,100	11,400	--	--	--	--	--	--	--	--	--	--
RR		14,000	8,000	5,600	--	--	--	--	--	--	--	--	--	--
SS		12,500	15,000	11,500	--	--	--	--	--	--	--	--	--	--
TT	W	5,400	14,000	2,400	5,200	0.5	1,845	57,300	--	1,640	--	67	--	--
GG	W	1,200	8,100	2,500	4,200	9.0	200	38,800	--	250	2,600	250	--	--
UU	W	11,600	2,300	1,155	420	--	10	2,000	--	--	--	1,020	--	--
VV	W	10,800	2,300	1,160	420	81	11	2,000	--	--	--	910	--	--
Metallo-organic														
WW	H	7,590	2,200	790	--	--	3,170	--	--	--	--	--	--	715 (Mn)
XX	H	8,000	1,500	670	--	--	1,645	--	--	--	--	--	--	450
YY	W	32,900	450	22	77	16	3,300	29,700	--	--	--	737	843	1,350 (Mn)

Note: Dash (--) indicates data not available, or data not determined.

a/ Source: Gruber (1976). Data taken from analysis of one plant.
b/ Source: Atkins (1972). The data given are reported as "typical" waste streams, and do not represent analyses from any particular plant or plants.
c/ Source: von Rumker, et al. (1974).
d/ Source: Meiners, et al. (1976).
e/ Source: Meiners, et al. (1976).
f/ Source: Reference No. 13, Section 3. See Table D-7
g/ Source: Weston (1975). In the case of multiple data for a specific pesticide, more than one plant was studied.
h/ Pesticide identification:

A - 2,4-D; dalapon; or 2,4,5-T.
B - PCP or sodium PCP.
C, D, E - Heptachlor, endrin, or isodrin.
F, G - Heptachlor or endrin
H, I, J, K, L, M, N, O - Coumaphos, disulfoton, azinphosmethyl, methamidophos, fensulfothion, fenthion, demeton, or methyl demeton.
P, Q, R - Parathion, methyl parathion, or Niran 6-3.
S - Composite of chlorpyrifos, crufomate, and ronnel.
T - Composite of methyl parathion and Aspon.
U, V, W, X - Sterofos, mevinphos, naled, or dichlorvos.
Y - Composite of fonofos, carbophenothion and bensulfide.
Z - Composite of sterofos, dichlorvos, naled, and mevinphos.
AA - Diazinon
BB - Composite of coumaphos, disulfoton, azinphosmethyl.
CC, DD - Metribuzin or benzazimide.
EE, FF - Atrazine, simazine, propazine, ametryne, prometryne, simetryne, sumitol, terbatryne, prometone, or cyanazine.
GG - Dinoseb
HH - Butylate, EPTC, vernolate, cycloate, molinate, or pebulate.
II, JJ, KK, LL, MM - Alachlor, CDAA, propachlor, butachlor.
NN, OO, PP, QQ, RR, SS - Diuron, bromacil, thiram, methomyl, linuron, or terbacil.
TT - Atrazine
UU, VV - Alachlor or propachlor.
WW - Manganese dithiocarbamate.
XX - Zinc dithiocarbamate.
YY - Manganese dithiocarbamate.

i/ Data type is represented as follows: H = Historical plant data.
W = Data obtained by Weston personnel during plant visits via sample collection and analyses.

j/ The total suspended solids do not represent measured data. Instead, the concentrations given are allowable wastewater concentrations proposed by Weston (1975).

Table D-3. RAW WASTEWATER CHARACTERISTICS OF ORGANIC PESTICIDE FORMULATORS

Wastewater flow rate	Wastewater characteristics (given in mg/ℓ)								
	pH	BOD_5	COD	TOC	S.S.	TDS	Phenol	Toxicant concentrations	Remarks
1,500-2,000 gpd[a]	--	--	483	--	661	631	--	Arsenic: 37	Measured in 1970
3,000 gpd[a]	--	--	--	--	--	--	--	2,4-D: 28.5 to 1,190 2,4,5-T: 3.91 to 162 Malathion: 2.06 Methoxychlor: 0.13	Measured in 1972
2,000 gpy[a]	4-7	--	--	--	--	--	0	Methyl orange: 34.2 Toxicants: < 1.0	Runoff plus wastewater, measured in 1973
2-5 gpm[a]	--	--	--	--	--	--	--	140 ppm total toxicants	--
240 gpd[b]	5.7-6.6	--	--	--	--	--	--	Chlorophenol residues: 0 ppm Eptam: 2 ppm (avg.) Sutan: 1 ppm (avg.) Ro-Neet: 2 ppm (avg.)	Measured in 1975

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[a] Ferguson (1975).

[b] Monitoring data from Stauffer Chemical Company, Portland, Oregon.

Note: Dash (--) indicates not determined or data unavailable.

Table D-4. MEASURED WASTEWATER QUALITY OF SELECTED INORGANIC PESTICIDE MANUFACTURERS

Parameter	Copper carbonate		Tri-basic copper sulfate		Sodium chlorate							
					Plant 1	Plant 2	Plant 3	Avg.	Plant 1	Plant 2	Plant 3	Avg.
Wastewater Flow (gal/ton product)	11,000		7,000		N.D.	2,300	N.D.	--	--	--	--	--
pH	6.3-6.5		5.9-7.0		6-8	6-10	6.4-7.3	--	--	--	--	--
	Concentration (mg/ℓ)	Discharge (lb/ton product)	Concentration (mg/ℓ)	Discharge (lb/ton product)	Concentration (mg/ℓ)				Discharge (lb/ton product)			
BOD_5	N.D.	N.D.	N.D.	N.D.	12	N.D.	6.7	9.35	12.73	N.D.	8.52	10.63
Dissolved solids	36,650	3,398	35,400	2,023	240	3,822	952	1,671.33	254.47	217.04	960.2	477.24
Suspended solids	59	5.47	240	13.71	10	216	14	80.0	10.62	12.27	17.90	13.60
NH_3-N	10	0.93	4,800	274	1.5	7	6.8	5.10	1.59	0.40	8.69	3.56
Sulfate	N.D.	N.D.	24,000	1,371	25	1,700	42.3	589.1	26.47	96.59	54.08	59.06
Chloride	16	1.48	3.4	0.19	55	1,200	276	510.33	58.24	68.18	352.84	159.75
Chromate	< 0.5	< 0.05	< 0.4	< 0.02	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Barium	N.D.	N.D.	N.D.	N.D.	8	N.D.	N.D.	8	8.47	N.D.	N.D.	8.47
Calcium	N.D.	N.D.	N.D.	N.D.	10	400	118	176	10.59	22.73	150.85	61.39
Sodium	N.D.	N.D.	N.D.	N.D.	100	1,000	142	414	105.88	56.82	181.53	114.74
Copper	13	1.21	136	7.77	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Iron	3.6	0.33	38	2.17	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Magnesium	1.0	0.09	1.5	0.09	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Manganese	0.1	0.01	0.17	0.01	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Nickel	0.1	0.01	0.9	0.05	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Lead	0.7	0.06	0.12	0.01	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc	1.3	0.12	1.4	0.08	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Source: Patterson (1975).

Note: N.D. means not determined.

Table D-5. ORGANIC PESTICIDE MANUFACTURERS' AND FORMULATORS' FINAL WASTEWATER EFFLUENT QUALITY MEASURED AFTER TREATMENT

		Wastewater effluent quality data										
Pesticide Category	Data type[a]	BOD$_5$ (mg/ℓ)	COD (mg/ℓ)	TOC (mg/ℓ)	Oil (mg/ℓ)	S.S (mg/ℓ)	Phenol (mg/ℓ)	Total phosphorus (mg/ℓ)	Total Kjeldahl nitrogen (mg/ℓ)	Cyanide (mg/ℓ)	Heavy metals (mg/ℓ)	Type of treatment
Halogenated organic manufacturer	P.V.	12	--	--	--	60	--	--	--	--	--	Trickling filter/ activated sludge
	H.R.	7	189	34	3.7	--	0.050	0.52	9.8	0.37	--	
Organo-phosphorus manufacturer	H.R.	50	--	--	--	25	0.500	--	--	--	--	Lime precipitation
Organo-phosphorus manufacturer	H.R.	--	272	187	--	38	0.005	24	0.65	--	--	Activated sludge
Organo-phosphorus manufacturer	P.V.	110	678	92	--	0.0	--	106	1.1	--	--	
	H.R.	80	575	106	0.5	42	0.020	8.0	4.8	0.02	--	Aerated lagoon
Organo-phosphorus manufacturer	P.V.	130	390	--	--	175	--	65	--	--	--	Alkaline hydrolysis/ oil separation
	H.R.	36	146	39	3.0	3	0.016	1.7	3.6	0.02	00	
Organo-phosphorus and organo-nitrogen manufacturer	P.V.	20	--	--	--	--	--	--	--	--	--	Cyanide removal/ aerated lagoon
	H.R.	8	--	--	--	19	0.066	0.5	24.6	0.02	--	
Metallo-organic manufacturer	P.V.	12.5	72.1	--	--	20.5	--	--	19.9	--	0.7(Mn)	Metals precipitation/ aerated lagoon
	H.R.	2	107	33	5.1	21	0.016	0.36	25	0.028	0.6(Mn)	
Formulator	P.V.	--	202	10	--	--	--	--	--	--	--	Oil separation/ aerated lagoon
	H.R.	9	60	32	0.5	216	0.002	0.42	6.2	0.02	--	

Source: Roy F. Weston, Inc. (1975).

[a] H. R. are data obtained from historical records of the plant.
P.V. are data obtained by plant visit and samples analysis performed by Roy F. Weston, Inc., personnel.

Note: Dash (--) indicates data not available.

[illegible] SOLID WASTES GENERATED BY PESTICIDE MANUFACTURERS AND FORMULATORS

Pesticide	Type of pollutant	Lb pollutant/lb pesticide (A.I.)	Units pollutant/unit time
Aldrin[a] manufacture	$Ca(OH)_2$	0.202	--
Captan[a] manufacture	Chemicals	--	1,200 lb/year
DDT[a] manufacture	Empty containers, bags, etc.	--	10-15 cu yard/day
2,4,5-T[a] manufacture	Phenolic wastes	--	50-75 lb/month
Organophosphorus[b] manufacture	Sludge	--	300 lb/day
Toxaphene[c] manufacture	Sludge (mostly lime)	--	7.5 ton/day
	Toxaphene	--	3 lb/day
Organophosphorus[d]	Sludge	--	2,400-24,000 lb/day
Halogenated organic[d]	Sludge	--	1,200 lb/day
Organo-nitrogen[d]	Sludge	--	2,160-14,900 lb/day
Metallo-organic[d]	Sludge	--	5,140 lb/day
Formulators[d]	Sludge	--	200 lb/day
Entire organic pesticide[e] manufacturing industry	Total discharge	0.331	170,953 metric tons/year
	Hazardous waste streams	0.297	153,233 metric tons/year
	Hazardous components	0.109	56,160 metric tons/year
	Highly Dangerous components	0.068	35,315 metric tons/year
Entire organic pesticide[e] formulating industry	Total discharge	0.0033 lb/lb/product	4,159 metric tons/year
	Hazardous waste streams	0.0033 lb/lb/product	4,159 metric tons/year
	Hazardous components	0.0013 lb/lb/product	1,683 metric tons/year
	Highly dangerous components	0.0008 lb/lb/product	1,003 metric tons/year

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[a] Lawless, et al. (1972).
[b] Atkins (1972).
[c] Meiners, et al. (1976).
[d] Weston (1975).
[e] Gruber (1976). Estimates are for 1973. Amounts of pollutants are given on a water-free basis.

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Table D-7. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM, DISCHARGE MONITORING REPORT - ATRAZINE

CIBA-GEIGY CORPORATION
MR D C MCINTYRE
P O BOX 11
ST GABRIEL LA 70776

LA ST	LA0005487 PERMIT NUMBER	301 DIS	SIC	LATITUDE	LONGITUDE	

REPORTING PERIOD FROM 7 6 | 0 3 | 0 1 (YEAR MO DAY) THRU 7 6 | 0 3 | 3 1 (YEAR MO DAY)

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum (and/or minimum as appropriate) permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.) If continuous enter "CONT."
5. Specify sample type ("grab" or "— hr. composite") as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.
7. Remove carbon and retain copy for your records.
8. Fold along dotted lines, staple and mail Original to office specified in permit.

PARAMETER		QUANTITY (3 card only) MINIMUM	QUANTITY AVERAGE	QUANTITY MAXIMUM	UNITS	NO. EX	CONCENTRATION (4 card only) MINIMUM	CONCENTRATION AVERAGE	CONCENTRATION MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED	1.9	2.8	4.3								Cont.	Record
	PERMIT CONDITION	N/A	N/A	N/A	MGD							"	"
TOC	REPORTED	734	3484	6425		0						Daily	24-hr comp
	PERMIT CONDITION	N/A	10,000	15,000	lbs/day							Daily	24-hr comp
BOD	REPORTED	460	1324	3513		0						1/wk	24-hr comp
	PERMIT CONDITION	N/A	3130	4695	lbs/day							1/wk	24-hr comp
COD	REPORTED	1854	9766	17,309		0						Daily	24-hr comp
	PERMIT CONDITION	N/A	16,000	24,000	lbs/day							"	"
TSS	REPORTED	856	2,794	5,805		0						"	"
	PERMIT CONDITION	N/A	18,000	27,000	lbs/day							"	"
Ammonia-N	REPORTED	4	153	631		0						"	"
	PERMIT CONDITION	N/A	1,100	1,650	lbs/day							"	"
Cyanide	REPORTED	0.2	0.2	0.5		0						"	"
	PERMIT CONDITION	N/A	3.0	4.5	lbs/day							"	"
Carbon Tetrachloride	REPORTED	3	5	9		0						"	"
	PERMIT CONDITION	N/A	50	75	lbs/day							"	"

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
Mincy, John W. LAST FIRST MI	Plant Manager TITLE	76 04 27 YEAR MO DAY	I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.	John W. Mincy SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

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Table D-7 (concluded)

CIBA-GEIGY CORPORATION
MR D C MCINTYRE
P O BOX 11
ST GABRIEL LA 70776

(2-3) ST	(4-10) PERMIT NUMBER	(17-19) DIS	SIC	LATITUDE	LONGITUDE
LA	LA0005487	301			

REPORTING PERIOD FROM 7 6 | 0 3 | 0 1 (YEAR MO DAY) XXX TO THRU 7 6 | 0 3 | 3 1 (YEAR MO DAY)

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum *(and/or minimum as appropriate)* permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. *(e.g., "3/7" is equivalent to 3 analyses performed every 7 days.)* If continuous enter "CONT."
5. Specify sample type (*"grab" or "__ hr. composite"*) as applicable. *If frequency was continuous, enter "NA".*
6. Appropriate signature is required on bottom of this form.
7. Remove carbon and retain copy for your records.
8. Fold along dotted lines, staple and mail Original to office specified in permit.

(32-37) PARAMETER		QUANTITY (3 card only) (38-45) MINIMUM	QUANTITY (46-53) AVERAGE	QUANTITY (54-61) MAXIMUM	QUANTITY UNITS	(62-63) NO. EX	CONCENTRATION (4 card only) (38-45) MINIMUM	CONCENTRATION (46-53) AVERAGE	CONCENTRATION (54-61) MAXIMUM	CONCENTRATION UNITS	(62-63) NO. EX	(64-68) FREQUENCY OF ANALYSIS	(69-70) SAMPLE TYPE
Toluene	REPORTED	12	43	197		0						Daily	24-hr comp
	PERMIT CONDITION	N/A	200	300	lbs/day							"	"
Atrazine	REPORTED	469	828	1559		0						"	"
	PERMIT CONDITION	N/A	1300	1950	lbs/day							"	"
Temperature	REPORTED								31		0	1/Day	Grab
	PERMIT CONDITION								41	°C		"	"
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
Mincy, John W. (LAST, FIRST, MI)	Plant Manager (TITLE)	7 6 0 4 2 7 (YEAR MO DAY)	*I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.*	John W. Mincy SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

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Table D-8. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM, DISCHARGE MONITORING REPORT - HERBICIDES

Monsanto Company
P. O. Box 473
Muscatine, Iowa 52761

ST: Ia
PERMIT NUMBER: 0000205
DIS:
SIC: 2818
LATITUDE: North 41°20'59"
LONGITUDE: West 91°04'18"

REPORTING PERIOD FROM 75 07 01 (YEAR MO DAY) TO 75 12 31 (YEAR MO DAY)

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum (and/or minimum as appropriate) permit conditions in the columns labeled "No. Ex." If none, enter "0".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.) If continuous enter "CONT."
5. Specify sample type ("grab" or "__ hr. composite") as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.
7. Remove carbon and retain copy for your records.
8. Fold along dotted lines, staple and mail Original to office specified in permit.

PARAMETER		QUANTITY					CONCENTRATION					FREQUENCY OF ANALYSIS	SAMPLE TYPE
		MINIMUM	AVERAGE	MAXIMUM	UNITS	NO EX	MINIMUM	AVERAGE	MAXIMUM	UNITS	NO EX		
Flow	REPORTED	6.202	7.319	8.687	MGD							1/day	NA
	PERMIT CONDITION		7.80	9.00									
BOD$_5$	REPORTED	9,686	12,236	21,515	lbs		47	194	370	PPM		1/day	24 hr comp
	PERMIT CONDITION		12,800	22,400									
COD	REPORTED	9,821	25,371	56,384	lbs	1	158	395	976	PPM		1/day	24 hr comp
	PERMIT CONDITION		32,000	56,000									
TSS	REPORTED	28	356	1,384	lbs		0.5	5.30	17.7	PPM		1/day	24 hr comp
	PERMIT CONDITION		1,200	5,000									
N-NH$_3$	REPORTED	1,746	7,568	12,159	lbs		25	118	199	PPM		1/day	24 hr comp
	PERMIT CONDITION		8,800	14,000									
Herbicides	REPORTED	195	528	2,869	lbs	1	3.2	8.2	49.1	PPM		1/day	24 hr comp
	PERMIT CONDITION		760	1,520									
pH	REPORTED	2.2		7.3								1/day	NA
	PERMIT CONDITION	1.8		9.0									
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER (LAST, FIRST, MI)	TITLE OF THE OFFICER	DATE (YEAR MO DAY)		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT
Solley, Larry W	Plant Manager	76 01 15	I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.	Albert A. Wicke

PAGE 1 OF 1

REFERENCES TO APPENDIX D

1. Atkins, P. R. The Pesticide Manufacturing Industry - Current Waste Treatment and Disposal Practices. 12020 FYE 01/72, January 1972.

2. Ferguson, T. L. Pollution Control Technology for Pesticide Formulators and Packagers. EPA-660/2-74-094, U.S. Environmental Protection Agency, January 1975.

3. Gruber, G. I. Assessment of Industrial Hazardous Waste Practices, Organic Chemicals, Pesticides, and Explosives. EPA Contract No. 68-01-2919, January 1976.

4. Ifeadi, C. N. Screening Study to Develop Background Information and Determine the Significance of Air Contaminant Emissions from Pesticides Plants. Batelle Report on Task 12, Contract No. 68-02-0611, March 5, 1975.

5. Lawless, E. W., R. von Rümker, and T. L. Ferguson. The Pollution Potential in Pesticide Manufacturing. OWP/EPA Technical Studies Report No. TS-00-72-04, June 1972.

6. Meiners, A. F., C. E. Mumma, T. L. Ferguson, and G. L. Kelso. Wastewater Treatment Technology Documents for Aldrin/Dieldrin, Endrin, Toxaphene, and DDT Manufacture and Formulation - four volumes. EPA Contract No. 68-01-3524, February 6, 1976.

7. Patterson, J. W. State-of-the-Art for the Inorganic Chemicals Industry: Inorganic Pesticides. EPA-600/2-74-009a, U.S. Environmental Protection Agency, March 1975.

8. von Rümker, R., E. W. Lawless, and A. F. Meiners. Production, Distribution, Use and Environmental Impact Potential of Selected Pesticides. EPA-540/1-74-001, U.S. Environmental Protection Agency, 1974.

9. Weston, R. F., Inc. Development Document for Effluent Limitations Guidelines and Standards Performance - Miscellaneous Chemical Industry. Draft Report, EPA Contract No. 68-01-2932, February 1975.

APPENDIX E

U.S. ENVIRONMENTAL PROTECTION AGENCY REGIONAL CONTACTS

Region I

Administrator

John A. S. McGlennon
J. F. Kennedy Federal Building
Boston, MA 02203
(617) 223-7210

Air Division

Lawrence M. Goldman, Chief
Air Compliance Section
J. F. Kennedy Federal Building
Boston, MA 02203
(617) 223-5610

Water Division

Lester A. Sutton, Director
J. F. Kennedy Federal Building
Boston, MA 02203
(617) 223-2226

Solid Waste Division

Dennis Huebner, Chief
J. F. Kennedy Federal Building
Boxton, MA 02203
(617) 223-5775

Pesticides Branch

A. Charles Lincoln
J. F. Kennedy Federal Building
Boston, MA 02203
(617) 223-5126

Region II

Administrator

Gerald M. Hansler
26 Federal Plaza
New York, NY 10007
(212) 264-2525

Air Division

Stuart Roth
Air Enforcement
26 Federal Plaza
New York, NY 10007
(212) 264-4711

Water Division

Charles N. Zursor, Chief
26 Federal Plaza
New York, NY 10007
(212) 264-1833

Region II (concluded)

Solid Waste Division	Michael F. DeBonis, Chief 26 Federal Plaza New York, NY 10007 (212) 264-0503
Pesticides Branch	Stanley H. Fenichel, Chief 26 Federal Plaza New York, NY 10007 (212) 264-8356

Region III

Administrator	Daniel J. Snyder Curtis Building 6th and Walnut Streets Philadelphia, PA 19106 (215) 597-9814
Air Division	John Rasnic Air Compliance Curtis Building 6th and Walnut Streets Philadelphia, PA 19106 (215) 597-0812
Water Division	Greene Jones, Director Curtis Building 6th and Walnut Streets Philadelphia, PA 19106 (215) 597-9410
Solid Waste Division	Charles Howard William Schremp, Representatives Curtis Building 6th and Walnut Streets Philadelphia, PA 19106 (215) 597-8114
Pesticides Branch	A. Nelson Davis, Chief Curtis Building 6th and Walnut Streets Philadelphia, PA 19106 (215) 597-9869

Region IV

Administrator

Jack E. Ravan
1421 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 526-5727

Air Division

James Wilburn
Air Enforcement
1421 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 526-5291

Water Division

Joseph Franzmathes, Director
1421 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 526-5727

Solid Waste Division

James Scarbrough, Head
1421 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 526-3016

Pesticides Branch

Roy P. Clark, Chief
1421 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 285-3621

Region V

Administrator

Francis T. Mayo
230 South Dearborn Street
Chicago, IL 60604
(312) 353-5250

Air Division

Thomas Voltaggio
Engineering Investigation
230 South Dearborn Street
Chicago, IL 60604
(312) 353-8730

Water Division

Henry Longest, II, Director
230 South Dearborn Street
Chicago, IL 60604
(312) 353-1050

Region V (concluded)

Solid Waste Division

Karl J. Klepitsch, Jr., Chief
230 South Dearborn Street
Chicago, IL 60604
(312) 353-6560

Pesticides Branch

Mitchell Wrich, Acting Chief
230 South Dearborn Street
Chicago, IL 60604
(312) 343-6219

Region VI*

Administrator

John C. White
1600 Patterson Street, Suite 1100
Dallas, TX 75201
(214) 749-1962

Air Division

Bruce Elliott
Enforcement Branch
1600 Patterson Street, Suite 1100
Dallas, TX 75201
(214) 749-1983

Water Division

Dr. Richard L. Hill, Director
1600 Patterson Street, Suite 1100
Dallas, TX 75201
(214) 749-1267

Solid Waste Division

Herbert Crowe, Representative
1600 Patterson Street, Suite 1100
Dallas, TX 75201
(214) 749-1121

Pesticides Branch

Norman E. Dyer, Chief
1600 Patterson Street, Suite 1100
Dallas, TX 75201
(214) 749-1121

---

* After August 20, 1976, the new address will be:
First International Building
1201 Elm Street
Dallas, Texas 75270

Region VII

Administrator	Jerome H. Svore 1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-5493
Air Division	Dewayne Durst 1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-3791
Water Division	Carl B. Blomgren, Director 1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-5616
Solid Waste Division	Morris G. Tucker, Chief 1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-3307
Pesticides Branch	John C. Wicklund, Chief 1735 Baltimore Avenue Kansas City, MO 64108 (816) 374-3036

Region VIII

Administrator	John A. Green 1860 Lincoln Street Denver, CO 80203 (303) 837-3895
Air Division	Robert Despain (Temporary) Enforcement Branch 1860 Lincoln Street Denver, CO 80203 (303) 837-4903
Water Division	Charles W. Murray, Jr., Director 1860 Lincoln Street Denver, CO 80203 (303) 837-4871

Region VIII (concluded)

Solid Waste Division	Lawrence P. Gazda, Chief 1860 Lincoln Street Denver, Colorado 80203 (303) 837-2221
Pesticides Branch	Ivan W. Dodson, Chief 1860 Lincoln Street Denver, CO 80203 (303) 327-3926

Region IX

Administrator	Paul DeFalco, Jr. 100 California Street San Francisco, CA 94111 (415) 556-2320
Air Division	Charles Seeley Air Compliance 100 California Street San Francisco, CA 94111 (415) 556-0970
Water Division	Sheila Prindville, Director 100 California Street San Francisco, CA 94111 (415) 556-0893
Solid Waste Division	Charles Bourns, Chief 100 California Street San Francisco, CA 94111 (415) 556-4606
Pesticides Branch	Jake Mackenzie, Chief 100 California Street San Francisco, CA 94111 (415-556-0217

Region X

Administrator	Clifford V. Smith 1200 6th Avenue Seattle, WA 98108 (206) 442-1220
Air Division	Clark L. Gaulding, Chief 1200 6th Avenue Seattle, WA 98108 (206) 442-1387
Water Division	Robert S. Burd, Director 1200 6th Avenue Seattle, WA 98108 (206) 442-1237
Solid Waste Division	Tobias A. Hegdahl, Chief 1200 6th Avenue Seattle, WA 98108 (206) 442-1260
Pesticides Branch	Robert A. Poss, Chief 1200 6th Avenue Seattle, WA 98108 (206) 442-1090

APPENDIX F

EPA PESTICIDE PROGRAMS

This section is devoted to a brief discussion of pesticide-related programs and was taken from a directory describing federal, state, and local environmental quality monitoring programs as related to pesticides published December 1974.[1] More recent activities of the EPA Office of Pesticide Programs related to regulatory actions and policy are described in Section VI.

The Environmental Protection Agency, since its creation in 1970, has participated in the cooperative, interagency National Pesticide Monitoring Program. At the present time, the Agency is operating five of the nine ambient pesticide monitoring networks. The networks for soil and raw agricultural crops, water, estuaries, and human tissue are currently operational. The Air Monitoring Network was operational for 2 years, but instrumentation difficulties forced the suspension of this program.

The following represents a summary of federal programs that cooperate in the National Pesticide Monitoring Program.

National Air Monitoring Program: This program was established in 1970 to detect pesticide residues in air. Because of technological difficulties, this program was suspended in 1972 until further field evaluations could be made. Upon completion of this study, the National Air Monitoring Program will be redesigned and reinstituted.

National Estuarine Monitoring Program: The objective of this program is to determine the presence or absence of persistent pesticide residues, establish baseline residue levels and detect trends. The program involves the semiannual collection of composite samples of herbivorous and carnivorous fish from 113 estuaries in the United States, the Virgin Islands and Puerto Rico. Samples are collected through contracts and voluntary assistance by state and university personnel.

National Water Monitoring Program: Since 1973, the program has been jointly sponsored by the U.S. Geological Survey which collects the samples and the U.S. Environmental Protection Agency which analyzes the samples. The 162 station network is designed to sample surface waters and sediment in order to establish baseline residue levels and changes thereof. Water samples are collected quarterly with sediment being collected semiannually.

National Soils Monitoring Program: The National Soils Monitoring Program was designed to determine average levels of pesticide residues in soils and agricultural crops in the United States and through periodic sampling, to determine changes in these levels. Two land-use categories are recognized: cropland and noncropland. One-quarter of the allocated sites in each state are sampled every year. At the time of harvest, soil and crop samples are collected at each site. Data on the crop and the kinds and amounts of pesticides applied to the site that season are also collected.

National Ocean Monitoring Program: The objective of this pilot program was to identify persistent, synthetic residues in commercial fish species and those intermediate in their food chain. This cooperative program with NOAA commenced in 1974 and collections were made in the offshore fishing grounds of the American fleet in the Atlantic, Caribbean and Pacific areas. NOAA collects the fish samples utilizing the scheduled resource survey cruises of the National Marine Fisheries Service. The results of the first year will be carefully reviewed and reported on prior to committing resources for a second year.

Analytical Support: Analytical support for all of the above programs is supplied by the Pesticide Monitoring Laboratory, Bay St. Louis, Mississippi. This laboratory is part of the TSD Ecological Monitoring Branch.

National Human Monitoring Program: This program was established in 1967 to determine on a national scale the incidences, levels, and other evidences of exposure to pesticides in the general population of the United States. The major operational element of the program collects adipose tissue and analyzes it for some 17 organochlorine pesticides and polychlorinated biphenyls. Pathologists are recruited according to an experimental design to take adipose tissue samples from post mortem examinations and from surgical specimens previously submitted for pathological examination. Samples are frozen and shipped under dry ice to two contract laboratory for residue analysis.

National Food and Feed Monitoring Programs: These programs are maintained by the U.S. Department of Agriculture and the Department of Health, Education, and Welfare. Programs currently being conducted include: (a) a continuing market basket study to determine residues in the basic 2-week diet of a 16 to 19-year-old male (statistically the nations largest eater), (b) nationwide surveillance of unprocessed food and feed, and (c) the surveillance program for red meat and poultry samples taken from animals in slaughter.

Pesticide Monitoring in Wildlife: The Bureau of Sport Fisheries and Wildlife, U.S. Department of Interior, is responsible for execution of these programs. Species selected for monitoring include the starling, mallard and black ducks, and the bald eagle. Starlings, the representative nonmigratory species, are collected from 128 sites across the country in alternate years. Duck wings, from mallard and black ducks, are available for monitoring purposes as a by-product of a nationwide waterfowl productivity survey in which cooperative hunters mail thousands of wings to central collection points for biological examination. The bald eagle is included in this national program because of its unique position at the top of estuarine food chains. Since this species is rigidly protected by law and the population levels are low, the only birds utilized for analysis are those found dead or incapacitated and beyond recovery.

National Fish Monitoring Program: The Bureau of Sport Fisheries and Wildlife also monitors freshwater fish at 100 locations in the continental United States. Each year composite samples of each of three species of fish are collection at each location.

REFERENCE TO APPENDIX F

1. Scotton, J. W., K. T. Mullen, J. Whitman, and R. Citron. Directory of EPA, State, and Local Environmental Quality Monitoring and Assessment Activities. National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia, PB-214 757, December 1974.

APPENDIX G

STATE ENVIRONMENTAL AGENCY CONTACTS

STATE ENVIRONMENTAL OFFICES

Alabama

Air Division

James W. Cooper, Director
Air Pollution Control Commission
645 South McDonough Street
Montgomery, Alabama 36109
(205) 834-6570

Water Division

James W. Warr
Chief Administrative Officer
Alabama Water Improvement Commission
State Office Building
Montgomery, Alabama 36130
(205) 277-3630

Charles R. Horn
Alabama Water Improvement Commission
Industrial Waste Control
State Office Building
Montgomery, Alabama 36130

Solid Waste Division

Alfred Chipley, Director
Division of Solid Waste and Vector Control
State Health Department
State Office Building
Montgomery, Alabama 36130
(205) 832-6758

Agricultural Chemistry Division

John H. Kirkpatrick, Director
Division of Agricultural Chemistry
Department of Agricultural and Industries
P.O. Box 2336
Montgomery, Alabama 36109

Alaska

Air Division

Thomas R. Hanna, Supervisor
Air Quality Control
Alaska Department of Environmental
Conservation, Pouch O
Juneau, Alaska 99811

Water Division

Jonathan W. Sribner, Director
Division of Water Programs
Alaska Department of Environmental
Conservation, Pouch O
Juneau, Alaska 99811

Ronald G. Hansen, Chief
Water Quality Control Section
Alaska Department of Environmental
Conservation, Pouch O
Juneau, Alaska 99811

Terrestrial Programs Division

Dale Wallington, Director
Division of Terrestrial Programs
Alaska Department of Environmental
Conservation, Pouch O
Juneau, Alaska 99811

Pesticides Division

Richard Stokes, Supervisor
Pesticides Branch
Alaska Department of Environmental
Conservation, Pouch O
Juneau, Alaska 99811
(907) 465-2635

Alaska

Extension Service Division

Peter Probasco
Alaska Cooperative Extension Service
Palmer Community College
Palmer, Alaska 99645

Agriculture Division

William E. Burgoyne, Ph.D.
Division of Agriculture
Alaska Department of Environmental
Conservation
P.O. Box 1088
Plamer, Alaska 99645

EPA Region X Representative

Stanley Brust
EPA Region X
605 W. Fourth Avenue
Anchorage, Alaska 99501

Arizona

Air Division

Nils Larson, Chief
Bureau of Air Pollution Control
Arizona Department of Health Services
Division of Environmental Health
1740 West Adams St.
Phoenix, Arizona 85007
(602) 271-5306

Water Division

Ronald Miller, Ph.D., Acting Chief
Bureau of Water Quality Control
Arizona Department of Health Services
Division of Environmental Health
1740 West Adams St.
Phoenix, Arizona 85007
(602) 271-5455

Arizona

Solid Waste Division

John Beck, Chief
Bureau of Sanitation
Arizona Department of Health Services
Division of Environmental Health
1740 West Adams St.
Phoenix, Arizona 85007
(602) 271-4641

Arkansas

Air Division

Jarrell Southall, Chief
Air Division
Arkansas Department of Pollution
Control and Ecology
8001 National Drive
Little Rock, Arkansas 72209
(501) 371-1136

Water Division

Hugh Hannah, Chief
Water Division
Arkansas Department of Pollution
Control and Ecology
8001 National Drive
Little Rock, Arkansas 72209
(501) 371-1701
General Office

Solid Waste Division

Ray Hightower, Chief
Solid Waste Division
Arkansas Department of Pollution
Control and Ecology
8001 National Drive
Little Rock, Arkansas 72209
(501) 371-1701
General Office

California

Air Division

William H. Lewis, Jr., Executive Officer
California Air Resources Borad
1709 - 11th Street
Sacramento, California 95814
(916) 322-2892

Water Division

Bill B. Dendy, Executive Officer
California Water Resources Control Board
P.O. Box 100
Sacramento, California 95801
(916) 445-9490

Solid Waste Division

Albert Marino, Executive Director
Solid Waste Management Board
Resources Building Room 1335
1416 North Street
Sacramento, California 95814
(916) 322-3330

Agricultural Chemical Division

California Department of Food and Agriculture
Division of Inspection Services
Agricultural Chemicals and Feed
1220 N Street Room A-268
Sacramento, California 95814

Hazardous Wastes Division

Dr. Harry Collins, Chief
Hazardous Waste Management Program
Department of Public Health
744 P Street
Sacramento, California 95814
(916) 322-2337

Colorado

Air Division

A. C. Bishard, Chief
Colorado Department of Health
Air Pollution Control Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 388-6111

Water Division

Robert J. Shukle, Chief
Colorado Department of Health
Water Quality Control Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 388-6111

Solid Waste Division

Orville F. Stoddard
Colorado Department of Health
Engineering and Sanitation Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 388-6111

Pesticides Registration Division

Robert Sullivan, Chief
Colorado Department of Agriculture
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APPENDIX H

STATE PESTICIDE RELATED ENVIRONMENTAL PROGRAMS - 1976

This section is devoted to a brief discussion of pesticide-related programs in 1976 as determined by letter and telephone contact. In some instances, no personal response was obtained and the information given is taken from a directory of EPA, state, and local environmental monitoring and assessment activities.[1/]

ALABAMA

The Pesticide Residue Laboratory performs statewide, random, and routine field work in terms of taking samples of all raw agricultural commodities and checking for pesticide residues. The laboratory cooperates with the State Department of Conservation by analyzing residues in any type of accidents concerning pesticides such as fish and wildlife kills.[1/]

The City Council of Huntsville adopted regulations for the control of pesticide emissions as an amendment to the air pollution control rules and regulations on May 22, 1975. No formal survey on air emissions from the pesticide industry has been taken in Huntsville area as of April 1976.[2/]

The Tri-County District Health Services of Decatur has not surveyed air emissions from the pesticide industry as of March 1976.[2/]

The Jefferson County Department of Health has no knowledge of any surveys or studies of the pesticide industry in Jefferson County having been conducted.[2/] (We have found there are at least 11 pesticide formulators in Jefferson County.)

ALASKA

The Department of Environmental Conservation reports that at present there are no monitoring programs for pesticides in Alaska.[1/] (There are no manufacturing or formulating operations in Alaska. Further, repackaging of pesticides is not permitted.)

ARIZONA

The Bureau of Sanitation in Phoenix performs monitoring of pesticide levels in food products. The Fisheries Division of the Department of Game and Fish in Phoenix has monitored pesticides in water in conjunction with federal agencies--EPA and Bureau of Sport Fisheries. Most work is concerned with other pollutants such as heavy metals.[1/]

ARKANSAS

The Department of Health monitors pesticides in air, water, meat, and milk. Additional monitoring of persons who load planes for aerial spraying, etc., is also carried out.[1/]

The Arkansas Department of Pollution Control and Ecology has sole responsibility for control of air emissions, effluents, and solid waste disposal. They are currently working with several pesticide producers that they are experiencing trouble with in relation to their emissions.[2]

CALIFORNIA

The Sacramento Monitoring and Surveillance Unit of the State Water Resources Control Board has performed pesticide studies in the past. Beginning with fiscal year 1976/1977, they will monitor for pesticides in bottom sediments according to the EPA regulations which will indicate areas of pesticide buildup where further studies will be needed. They will begin water column sampling in fiscal year 1976/1977 at appropriate state areas with high pesticide use or specific water quality problems related to pesticides.[1]

The Inspection Services of the Department of Food and Agriculture and three other laboratories in the state perform daily screening of raw agriculture products and investigate isolated problems such as accidents caused by pesticides.[1]

EPA Region IX in San Francisco has no record of specific pesticide emissions in their region.[2]

An inspection of the pesticide plant owned and operated by Chevron Chemical at Richmond was completed on March 29 and 30, 1976. It was learned that the plant capacity will be doubled in the near future. No air emissions samples were taken at the time of the inspection.[2]

The Air Resources Board in Sacramento is not aware of any air emissions from the pesticide industry in California.[2]

The Water Resources Control Board only reports general information about agencies that would be concerned about pesticide control. No specific information about pesticide programs was given.[2]

COLORADO

Once a year the Department of Agriculture monitors water sources. Otherwise only accidents involving commercial applications are investigated.[1]

The Epidemiologic Pesticide Studies Center at Colorado State University in conjunction with EPA has done monitoring for pesticides in air, house dust, reservoir water, soil, and human tissue.[1]

EPA in Denver has no information regarding pesticide emissions.[2]

In 1971 the Colorado Community Pesticide Program at Greeley sampled ambient air for pesticide active ingredient.[3] The study was not expanded at that time but some small amount of air sampling under contract to the EPA at four different sites recently was completed. The results are not yet available for publication.[2,4]

Shell Chemical Company has operated a pesticide manufacturing plant for many years on the Rocky Mountain Arsenal property northeast of Denver. Recently there have been reports of dicyclopentadiene, a pesticide precursor, entering nearby surface and groundwaters in low parts per million concentration levels.[2,5,6]

Diisopropylmethylphosphonate (DIMP), a by-product of the chemical destruction and manufacture of GB nerve gas, was initially disposed of to two lakes on the arsenal property from 1957 to the early 1960's after which the practice was discontinued. DIMP has now been found in a series of wells both on and off the arsenal property. Concentrations of DIMP ranged from 1, to 48, to 400 ppm for various off-site wells, on-site wells, and an on-site lake, respectively.[2,5,6]

Balcolm Chemical, Inc., a formulator at Greeley, recently began a pesticide drum rinsing operation to reclaim used pesticide drums. Thimet residues from the rinsing operations will be treated with caustic prior to disposal in the Greeley sewage system.[2,5]

CONNECTICUT

On July 1, 1974, the Water Compliance Unit of the Department of Environmental Protection initiated trend monitoring for pesticides in yearly sediment samples.[1]

The Connecticut Department of Environmental Protection has one unit, Pesticide Compliance, that regulates activity affecting manufacturing industry in areas of discharge into air or water and disposal of solid waste.[2]

DELAWARE

The Technical Services Section of the Department of Natural Resources samples water from the Delaware River quarterly taking about 34 samples annually. They have monitored offshore ocean waters including aquatic organisms and sediment. The monitoring program of streams in the state will increase in the near future.[1]

DISTRICT OF COLUMBIA

The Environmental Health Administration has made budgetary provisions for the coming fiscal year for monitoring pesticide residue levels indoors and outdoors. It is concerned mainly with households since the District is not a rural area.[1] (There are six formulators in the District of Columbia.)

FLORIDA

The Department of Pollution Control has 100 stations throughout the state to scan pesticide residues in sediment and fish on an annual basis. The Department investigates accidents involving pesticide misuse. They plan to begin monitoring in connection with the inspection of sites of pesticide formulations.[1]

The Game Research Office of the Fish and Game Commission in Gainsville is involved with two major pesticide monitoring studies. One study concerns brown pelicans around the Florida coast, and samples are taken once a year during the nesting season. This study started in the late 1960's. The second study which has been completed involves monitoring mirex bait distributed for the control of fire ants and procuring specimens. They also investigate accidental pesticide misuse.[1]

The Pesticide Residue Laboratory of the Department of Agriculture's primary responsibility is to monitor pesticide residue levels in food including fish and shellfish. They also investigate accidental pesticide misuse.[1]

The University of Miami School of Medicine study has been examining pesticides in air in south Florida since 1973.[7,8] In order to trap and concentrate the very low level of pesticides occurring in air, a double impinger-trap system was employed. Ethylene glycol was found to have excellent trapping qualities for pesticides entering in an air stream. The impingers were originally developed by Midwest Research Institute and have been described earlier.[9] Trapping efficiencies generally ranged from 80 to 100% recovery as proven by use of spiked samples and depended on the pesticide.

After trapping the pesticide, the ethylene glycol solution was subjected to a multiclass-multiresidue separation procedure based on silica gel chromatography using a series solvents of increasing polarity.[10] Identification of the pesticides fractions was accomplished by GC-MS.

Quantification was achieved by GLC using columns optimized for maximum peak separation and sharpness using specific detectors; a tritium foil electron capture detector for organochlorine pesticides and a flame photometric detector for organophosphorus pesticides.[10]

GEORGIA

The Pesticide Division of the Department of Agriculture performs food and environmental monitoring for pesticides and investigates problems in the field relating to pesticide application.[1]

The Laboratories Division does surveillance of raw agriculture products--leafy vegetables and milk. The Division also monitors animal, feed, pondwater, and miscellaneous media for regulatory purposes.[1]

HAWAII

There is no information about pesticide monitoring in Hawaii.[1] There has been no pesticide monitoring in Hawaii as of February 1976.[2]

IDAHO

EPA sponsors 12 community studies through the Deparment of Health and Welfare that monitor pesticides in all media in relation to human health.[1]

ILLINOIS

EPA monitors pesticides in terms of a general overall water quality program. They sample water, bottom sediments, and fish in Lake Michigan and its tributaries.[1]

The Department of Public Health monitors milk supplies, feed, and meat for pesticides. They also investigate poisoning in children.[1]

The State Natural History Survey monitors pesticides in milk, meat, soybeans soil, water, terrestrial and aquatic life.[1]

There are no specific regulations, monitoring requirements, or emissions and/or effluent standards for pesticide manufacturing facilities.[2]

There has never been a survey on air emissions from the pesticide industry in Region V.[2]

INDIANA

The State Board of Health periodically monitors pesticides in fruits, vegetables, and milk.[1]

The Water Quality Surveillance of the State Board of Health has stopped a 3-year monitoring program in Lake Michigan since they were not able to find significant problems.[1]

The Stream Pollution Control Board is not actively involved in any study of emissions as of February 1976.[2]

IOWA

The Pesticide Section of the Department of Agriculture monitors foods, especially dairy products, meat, vegetables, and feed ingredients. They also investigate on a case-by-case basis the misuse and abuse of pesticides and crop residues.[1/]

The Iowa Conservation Commission has performed some environmental monitoring specifically for dieldrin in fish and pheasants.[1/]

The Chemical Technology Division of the Department of Environmental Quality works with Iowa State University in investigating incidents of pesticide related environmental damage and also monitors farm runoff.[1/]

KANSAS

The work on monitoring the air around Topeka by the Department of Health has been recently suspended. It may be resumed in the future.[1/]

KENTUCKY

Since 1966, the Consumer Product Safety Section of the Department of Human Resources has maintained statewide comprehensive surveillance of intrastate commercially produced raw agriculture products for compliance of permissible pesticide residues. Special studies have been discontinued that involved monitoring of pesticides in ambient air and pesticide residues in major watersheds.[1/]

The Department of Natural Resources Environmental Protection currently monitors stream runoff, air, and milk for pesticide content and monitoring of manufactured pesticides to determine if the contents are the same as stated on the label.[1/]

LOUISIANA

The Feed and Fertilizer Laboratories at Louisiana State University is a pesticide regulatory agency. It also does some monitoring of fish, wildlife, water, meat, and animal feed.[1/]

The Louisiana Air Control Commission currently routinely checks permits and emission inventory questionnaires for possible problem insecticide emissions. Special studies are accomplished as necessary.[2/]

MAINE

The Division of Inspection of the Department of Agriculture performs monitoring of pesticides in feeds only.[1/]

The Fish and Game Department performs monitoring of pesticides in salmon in Serago Lake.[1]

MARYLAND

The Inspection and Regulation Division of the Department of Agriculture performs mainly duties such as checking labeling and guarantees on formulations sold. It also monitors pesticide residues in meat, vegetation, soil, and public water supplies.[1]

MASSACHUSETTS

The only routine monitoring program involves chlorinated hydrocarbons in fish. Estuary studies have been conducted through the Division of Marine Fisheries. Special programs investigating accidents with pesticides are run occasionally.[1]

EPA conducted a survey and emission test for the period September 10 through 12, 1974, at the General Electric Company, Pittsfield, Massachusetts, relative to the disposal of pesticides. The test program was to establish capability of the Company's thermal oxidizer to process and dispose of a liquid formulation in an environmentally acceptable manner.[2]

MICHIGAN

The Food Inspection Division performs year-round monitoring of all fresh produce including milk and meat. Meat is monitored on a less regular basis.[1]

The Water Quality Control Division in conjunction with several state and federal agencies carries out annual surveys of dieldrin and DDT in Great Lakes fish, and also annually samples Great Lakes tributaries for dieldrin and DDT in addition to other pesticides. Since 1968, they have been monitoring dieldrin and chlordane on a yearly basis in Bervien County where controlled pesticide treatments for Japanese beetles have been conducted.[1]

Neither the Michigan Department of Natural Resources nor any of the local air pollution agencies conduct a program of air monitoring of emissions specifically related to the pesticide industry.[2]

MINNESOTA

The Department of Agriculture performs ongoing surveillance for pesticides in food and feedstuffs, and in conjunction with the State Health Department, checks pesticide levels in well water. The Department of Natural Resources routinely monitors pesticide levels in fish. Analysis on other wildlife is sporadic. The State Pollution Control Agency performs semiannual statewide monitoring of water for pesticides.[1]

MISSISSIPPI

The state and federal government through the Game and Fish Commission sponsors continual monitoring of lakes and fish in Mississippi, especially in the Delta area. It has closed three lakes on the basis of information obtained. They also monitor game.1/

The Imported Fire Ant Control Division in the Department of Agriculture monitors air, water, soil, and living organisms for pesticides used in fire ant control.1/

MISSOURI

The Bureau of Pesticide Control reports that the only monitoring that is done or will be done is in conjunction with the USDA concerning residues in soils and crops.1/

The Division of Environmental Quality through the Clean Water Commission staff has been approved by EPA for the administration of the National Pollutant Discharge Elimination System Permit Program. The program requires that a permit be obtained to discharge effluents to the waters of the state. The sampling of the effluent and analysis of the sample to establish compliance with water quality standards is the responsibility of the permit holder.2/

The Air Conservation Commission staff does not have a specific program involving the pesticide industry.2/

MONTANA

The Health and Environment Sciences Department's Pesticides Demonstration Program in conjunction with EPA monitors food, crops, and water during and after spraying when high levels are suspected, and not routinely, but in response to reports of incidents of misuse. Routine monitoring stopped in 1972; it may be resumed in connection with chemicals disposal site.1/

NEBRASKA

The Plant Protection Division, USDA, cooperates with the federal USDA/EPA program in Nebraska and Kansas. No monitoring is carried out through state agencies.1/

The Air, Water, and Solid Wastes Division of the Department of Environmental Control has permit programs limiting the quantity and quality of discharges and/or emissions. The Solid Waste Division is currently conducting a hazardous waste disposal study to determine what, where, and under what conditions or control hazardous waste may be placed in sanitary landfills.2/

The USDA monitors pesticide formulations for chemical ingredients to see that they meet the guarantee on the label.[2/]

NEVADA

The Cooperative Extension Service of the College of Agriculture at the University of Nevada carries out only monitoring in the state. It monitors air, water, soil, vegetation, wildlife, etc., around four pesticide disposal sites.[1/]

NEW HAMPSHIRE

The State Laboratory Building samples all types of environmental media for pesticides, only for isolated complaints or incidents. They are hampered by the lack of funds for other monitoring.[1/]

The State of New Hampshire has no pesticide industry.[2/] (There are 10 formulators in New Hampshire.)

NEW JERSEY

Routine analysis of water, food, and milk is performed by the Health Department.

Air is no longer routinely monitored, but they investigate specific incidents or complaints.[1/]

The Department of Environmental Protection has no control activities directed toward the pesticide industry per se. Any controls on pesticide manufacturing and formulation are subject to the same air pollution control regulations applicable to all industrial sources.[2/]

NEW MEXICO

The Environmental Improvement Agency performs monitoring for pesticides on a small scale only. It currently monitors vector control crews. They are now in the process of setting up monitoring for raw agricultural commodities and are trying to set up two air monitors in one specific location where herbicide problems have existed. Most efforts are restricted to specific problems of accidents concerning pesticides.[1/]

The EIA, Environmental Chemicals and Monitoring and Training, has two specific programs under contract with EPA. One is a survey to identify sources of toxic and hazardous wastes and ultimately to assess the effectiveness of the disposal of these wastes. The other program is for multimedia environmental monitoring for pesticide residues in water courses, stream bottom sediments, raw agricultural commodities, and air in the State of New Mexico. The programs are not specifically involved in the pesticide industry because there is no significant pesticide industry in New Mexico.[2/] (There are 13 formulators in New Mexico.)

The EIA, Water Quality Division, has sections that monitor agriculture pesticide drift and cholinesterase testing in pesticide personnel. Monitoring for pesticides in milk is carried out by the Food Quality Division.[2/]

NEW YORK

The Pesticides Bureau of the Department of Environmental Conservation performs monitoring sporadically. It monitors pesticides in water once or twice annually. Air monitoring has been discontinued.[1/]

The Food Control Division of the Department of Agriculture monitors food for a variety of substances including pesticides.[1/]

The Meat Inspection Division monitors meat and poultry for a variety of substances including pesticides.[1/]

NORTH CAROLINA

The Food and Drug Division of the Department of Agriculture performs monitoring for pesticides in conjunction with the inspection of food, feed, and dairy products.[1/]

The Department of Natural and Economic Resources monitors stream water for pesticides and is planning to monitor water, fish, and to examine bottom sediments annually.[1/]

The Water Quality Section of the Department of Natural and Economic Resources is not monitoring surface waters for pesticides on a routine basis. Pesticide sampling is done only in connection with environmental emergencies.[2/]

The Air Quality Section reports that no pesticide emission monitoring is conducted.[2/]

The Pest Control Division monitors disposal sites routinely and samples for pesticide residues in ground and surface waters. Foods are also routinely examined for pesticides.[2/]

NORTH DAKOTA

The Water Supply and Pollution Control Division of the Department of Health monitors stream water for pesticides. They are planning eventually to begin monitoring more extensively by including bottom sediments, etc.[1/]

OHIO

The Environmental Evaluation Section of EPA in Ohio monitors mainly surface waters, fish, bottom aquatic life, and bottom sediments.[1]

EPA in Ohio is currently monitoring and taking samples monthly from 26 statewide surface water sites that are checked for 15 different organochlorine pesticide parameters.[2]

The Hazardous Waste Section of EPA's Land Pollution Control Division is conducting a survey among manufacturers of hazardous wastes of the quantities disposed of in the state. A follow-up study will be conducted to see whether it is being disposed of properly.[2]

There is no program in the Division of Air Pollution Control pertaining to pesticide emissions and no air quality standards have been set.[2]

OKLAHOMA

The Plant Industry Division of the Department of Agriculture samples grain and feed, as well as soil and groundwater in agricultural areas. This is done only when there is a demand for it, the particular season warrants it or in the case of contamination.[1]

The Department of Pollution Control serves a coordinating function for this Department of Agriculture's monitoring for pesticides in water.[1]

The Water Quality Division of the Water Resources Board collects pesticide samples (both water and sediment) at 26 selected points across the state. All of the major stream systems are monitored on a quarterly basis.[1]

The Department of Health runs its own independent programs which monitor runoff, milk, and foods. Air monitoring was recently halted. It also investigates accidental pesticide related incidents in whatever environmental medium it happens to affect.[1]

OREGON

The Laboratory Services Division of the Department of Agriculture monitors all foods including dairy products, some frozen and processed foods, and animal feeds. It also monitors soil, water, wildlife, etc., in all cases where pesticides are used on federal and state lands. It is also currently monitoring DDT levels in certain areas of Douglas firs.[1]

PENNSYLVANIA

The Water Quality Division of the Department of Environmental Resources is conducting monitoring on a small scale for effects on streams of spraying for gypsy moths.[1]

The Division of Pesticide Community Studies of the Department of Environmental Resources is currently conducting a survey which will involve all of the 185 pesticide producing industries in Pennsylvania which are registered with EPA pursuant to Section 7 of FIFRA as amended. A questionnaire has been distributed to these establishments soliciting information of the types and quantities of pesticide products being produced and the nature of liquid and solid waste products being generated. The Department's Bureau of Air Quality and Noise Control will be examined to determine those industries which have submitted an emissions inventory. This project is designed to act as a focal point for evaluating environmental problems associated with pesticides.[2]

RHODE ISLAND

The Laboratories Division of the Department of Health performs routine analyses for pesticides in both water and food. It also investigates pesticide levels after isolated sprayings.[1]

Although there are extensive air pollution and emission control programs in Rhode Island, none specifically involve pesticides.[2]

SOUTH CAROLINA

The Department of Health and Environmental Control carries out a limited amount of monitoring on surface waters used for public supplies and some on soil. Only a very small amount is done on wildlife and aquifers on demand or a problem basis only.[1]

The College of Agriculture at Clemson University in Clemson monitors soil and water in connection with the Fire Ant and Witch Weed Control Programs.[1]

The Medical University of South Carolina in Charleston is conducting some monitoring for pesticide levels in humans.[1]

The Bureau of Air Quality Control has no statutory or regulatory role in the control or monitoring of pesticides in the State of South Carolina.[2]

SOUTH DAKOTA

The Solid Wastes and Pesticide Program of the Department of Environmental Protection has equipment for routine monitoring but mostly investigates accidents as they occur. It also has a computer program which codes information concerning all commercial applications which can be correlated with accident reports. Air monitoring was recently stopped for financial reasons.[1]

The Department of Environmental Protection has no knowledge of any industry in South Dakota that manufactures or formulates pesticides.[2] (There are 24 pesticide formulators in South Dakota.)

South Dakota University does some research involving pesticide monitoring of streams and rivers in South Dakota.[2]

TENNESSEE

The Food and Drug Division of the Department of Agriculture monitors pesticide residues in dairy products in conjunction with FDA and in livestock in conjunction with USDAx It also monitors other materials such as flour, leaves, pondwater, and soil.[1]

The Department of Health monitors pesticide levels in milk, water, air, and human tissue.[1]

TEXAS

The Environmental Consumer Health Protection Department of Health monitors pesticide and radiation levels in milk, water, air, and human tissue.[1]

There is no specific pesticide monitoring being routinely conducted for air emissions in Texas as of February 1976.[2]

The Texas Air Control Board has investigated air emissions from Central International Chemicals of Liberty, Texas, resulting from citizen complaints dating to March 1972. The facility formulates a number of pesticides including Imidan [(N-mercaptomethyl)phthalimide S-(0,0-dimethyl phosphorodithioate)] which has a particularly offensive odor and may be compared to the odor of rotten cabbage. Central International Chemicals modified the emissions control equipment in an effort to alleviate odor complaints in April 1973 but Imidan odors continue to be detected near the plant.[2]

The Texas Air Control Board has requested the formulator to advise them 30 days in advance of any product line changes, including new pesticides and formulations. Air samples near the facility are taken whenever citizen complaints are received. The plant itself is inspected every 2 years.[2]

UTAH

The Environmental Health Bureau in conjunction with EPA's Community Pesticide Program monitors air, water, soil, and wildlife mostly on a grab-bag sampling basis. Air monitoring was stopped recently for lack of significant results. Pesticide related incidents are also investigated.[1/]

The Utah Epidemiologic Studies Project has not investigated any pesticide episode involving emissions from pesticide industries.[2/]

VERMONT

The Water Quality Division of the Agency of Environmental Conservation will begin monitoring surface waters for pesticides by the end of summer.[1/]

Vermont has formed a Pesticides Advisory Council.[2/]

VIRGINIA

The Food Inspection Section of the Department of Agriculture maintains a routine check on food products. The Pesticide, Paint, and Hazardous Substances Section investigates all pesticide related accidents or incidents of misuse but does not perform routine monitoring activities.[1/]

The State Water Control Board operates 100 stations throughout the state to monitor water. Samples are taken bi-annually depending upon seasons of spraying or application.[1/]

The State Air Pollution Control Board has no knowledge of air emission studies on pesticides since 1971.[2/]

WASHINGTON

The Department of Social and Health Services in conjunction with EPA's Community Pesticides Program monitors storage levels in humans and principal routes of human exposure to pesticides. It also surveys agricultural usage of pesticides in the state and investigates all suspected accidents involving pesticide use.[1/]

Neither the Air Programs Branch nor the Pesticides Branch of the U.S. EPA Region X has undertaken surveys on air emissions from pesticides manufacturers or formulators nor do they have knowledge of any data from studies by other interested parties.[2/]

APPENDIX I

REBUTTABLE PRESUMPTION CATEGORY IV CHEMICALS AND TENTATIVE SCHEDULE OF PRESUMPTION NOTICE

Under the amended Federal Insecticide, Fungicide and Rodenticide Act (1975), the Environmental Protection Agency (EPA) must re-register all pesticides to determine their efficacy, safety, and long-term environmental impact. This includes estimating the chemical's benefit versus its risk. To carry out this mandate the EPA may require more long- and short-term information, e.g., mutagenic, carcinogenic, and other toxicity studies. Alternately, the EPA may presume against registration if the risks outweigh the benefits.

Several categories have been defined to indicate the types of information required for pesticide active ingredient re-registration. These are:

Category I -	Those active ingredients for which all required data, e.g., toxicity data, residue studies, chronic feeding studies, etc., to support re-registration are available.
Category II -	Those active ingredients for which long-term testing data, e.g., teratogenicity and chronic feeding studies are lacking.
Category III -	Those active ingredients for which short-term testing data, e.g., acute oral and dermal toxicity studies are lacking.
Category IV -	Those active ingredients that show evidence of posing potential unreasonable risk to human health and/or the environment.
Category V -	Those active ingredients which do not fit into the above categories.

As of the date of this report the EPA has not officially assigned any active ingredients to Category IV. However, a provisional listing of approximately 100 chemicals has been compiled based on existing evidence, unverified studies from the scientific literature, or a chemical similarity to cancelled pesticide active ingredients. Various reasons or rationales have been advanced for placing an active ingredient in Category IV and include the following: Actual or potential carcinogenicity, embryotoxicity, delayed neurotoxicity, population reduction to nontarget organisms, hazard and/or fatality to nontarget or endangered species.

The decision to list various active ingredients in Category IV is tentative and is based on a presumption of unreasonable risk to various life forms and/or the environment. If after an extensive scientific review of appropriate data for each of the active ingredients placed in Category IV there still remains an unreasonable risk, the active ingredients may be denied re-registration and withdrawn from the market.

At this point registrants, users, the scientific community, and the general public will have the opportunity to rebut the presumptive risk. This potential sequence of events has led to Category IV being termed a Rebuttable Presumption Category. These factions will be given every opportunity to demonstrate that the risk is not as substantial as originally presumed, that it may be reduced through labeling and other use restrictions, or that the benefits of the active ingredients outweigh the risk involved and thus, support re-registration. Thus, the placement of a particular active ingredient in Category IV could trigger a Reubttable Presumption Against Registration (RPAR). Further details may be found in the Federal Register and other sources.[1-3] The listing of chemicals presently included in Rebuttable Presumption Category IV as obtained from the EPA follows in Appendix I.

Subsequent to the release of the Rebuttable Presumption List of Pesticides in February 1976, the EPA has indicated the order in which the pesticides will be scheduled for presumption against re-registration.[4] The schedule is given after this Rebuttable Presumption List in Appendix I.

REFERENCES TO APPENDIX I

1. Federal Register, February 19, 1976.
2. Pesticide Chemical News, p. 15, March 3, 1976.
3. Chemical and Engineering News, p. 19, March 22, 1976.
4. Chemical and Engineering News, p. 18, June 14, 1976.

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
22		Ammonium arsenite			Cancer	Decision under review
99		Anilinocadmium dilactate			Cancer: Testicular atrophy	
23		Arsenic acid; Orthoarsenic acid		H,X	Cancer	Decision under review
12		Arsenic pentoxide			Cancer	Decision under review
12		Arsenic sulfide		R	Cancer	Decision under review
23		Arsenic trioxide		R	Cancer	Decision under review
15	BHC	Benzene hexachloride, other isomers		I	Cancer	Hearing awaiting further study
13		2-(p-tert-Butylphenoxy)-1-methylethyl 2-chloroethyl sulfite	Aramite; Aracide	I	Cancer	
23	Cacodylic acid	Dimethylarsinic acid	Silvisar 510	H,X	Cancer	Decision under review

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
23	Cacodylic acid, sodium salt	Dimethylarsenic acid, sodium salt			Cancer	Decision under review
21		Cadmium-calcium-copper-zinc-sulfate-chromate complex		F	Cancer; testicular atrophy	
21		Cadmium carbonate		F	Cancer; testicular atrophy	
21		Cadmium chloride		F	Cancer; testicular atrophy	
21		Cadmium sebacate		F	Cancer; testicular atrophy	
21		Cadmium succinate		F	Cancer; testicular atrophy	
21		Cadmium sulfate		F	Cancer; testicular atrophy	
23		Calcium acid methane-arsonate			Cancer	Decision under review
12		Calcium arsenate; Tricalcium arsenate			Cancer	Decision under review
12		Calcium arsenite; Mono-calcium m-arsenite			Cancer	Decision under review

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
21		Calcium ethylenebisdithiocarbamate	Dithane-calcium	F	Thyroid cancer	
12		Calcium propanearsonate			Cancer	Decision under review
11		Carbon tetrachloride		I	Cancer	
21	Chloranil	Tetrachloro-p-benzoquinone	Spergon	F	Possible carcinogen	
15	Chlordane	60% Octachloro-4,7-methanotetrahydroindane and 40% related compounds	Ortho-klor	I	Cancer	
13	Chlorobenzilate	Ethyl 4,4'-dichlorobenzilate		I	Cancer	
	Chloroform	Trichloromethane			Cancer	
99		Chloromethoxypropylmercuric acetate			Embryotoxic	
24		Coal tar, creosote		I,F,D	Cancer	
11	Compound 1080	Sodium fluoroacetate		M,R	Population reduction to nontarget organisms	Hearing awaiting further study
12		Copper arsenite			Cancer	Decision under review
21	DBCP	1,2-Dibromo-3-chloropropane	Nemagon;Fumazone	N,I,F	Stomach cancer	
25	Di-allate	S-(2,3-Dichloroallyl)diisopropylthiocarbamate	Avadex	H	Cancer	

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
21		Diammonium ethylene bisdithiocarbamate	Amoban		Thyroid cancer	
16	Dimethoate	O,O-Dimethyl S- (methylcarbamoyl)-methyl phosphorodithioate		I	Cancer	
22		Di(phenylmercury)dodecenylsuccinate		F	Embryotoxic	
		Di-n-propylmaleate isosafrole condensate; n-Propyl isomer			Cancer	
23	DSMA	Disodium methanearsonate		H	Cancer	Decision under review
23		Dodecylammonium methanearsonate			Cancer	Decision under review
		Endrin			Hazard to nontarget and endangered species	
22		Ethylmercury phosphate				
12	EPN	O-Ethyl O-p-nitrophenyl phenylphosphonothioate		I	Delayed neurotoxicity	
25	Erbon	a-(2,4,5-Trichlorophenoxy)ethyl 2,2-dichloropropionate		H	Dioxin	Delayed
	Ethylene dibromide	1,2-Dibromoethane		F	Stomach cancer	

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
15	Heptachlor	Heptachlorotetrahydro-4,7-methanoindene and related compounds		I	Cancer	Hearing
99		3,4,5,6,7,7-Hexachloro-N-(methylmercuri)-1,2,3,6-tetrahydro-3,6-endomethanophthalimide	Memmi		Embryotoxic	Hearing
23		Lead acetate		F	Cancer	
16		Lead arsenate		I,F,P	Cancer	Decision under review
16		Lead arsenate, basic			Cancer	Decision under review
23	MAMA	Monoammonium methanearsonate		H	Cancer	Decision under review
21	Mancozeb	Zinc ion and manganese ethylenebisdithio carbamate	Dithane M-45; Manzate 200	F	Thyroid cancer	
21	Maneb	Manganese ethylenebisdithiocarbamate	Manzate; Dithane M-22	F	Thyroid cancer	
25	Merphos	Tributyl phosphorotrithioate	Folex	X	Delayed neurotoxicity	
22		Mercuric chloride	Corrosive sublimate	F	Embryotoxic	Hearing
22		Mercuric oxide		F	Embryotoxic	Hearing
22		Mercurous chloride	Calomel	F	Embryotoxic	Hearing
22		Methyl mercury quinolinolate	Metasol	F	Embryotoxic	Hearing

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
12	Mirex	Dodecachlorooctahydro-1,3,4-methene-1H-cyclobuta[cd] pentalene		I	Cancer	Hearing
25	Monuron	3-(p-Chlorophenyl)-1,1-dimethylurea		H	Cancer	
23	MSMA	Monosodium acid methanearsonate		H	Cancer	Decision under review
21	Nabam	Disodium ethylenebisdithiocarbamate		F	Thyroid cancer	
25		Octyl ammonium methanearsonate		F	Cancer	Decision under review
17		Oil of camphor sassafrassy		I	Cancer	
22		10,10'-Oxybisphenarsazine			Contains arsenic (cancer)	Decision under review
22		10,10'-Oxybisphenoxarsine		F,S	Contains arsenic (cancer)	Decision under review
99	Paris green	Copper acetoarsenite			Cancer	Decision under review
24	PCP	Pentachlorophenol		H,I,F,K	Photodegrades to dioxin	
24		Phenarsazine chloride		H	Cancer	Decision under review
22		Phenyl mercuric acetate	PMA	D	Embryotoxic	Hearing

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
22		Phenylmercuric ammonium acetate		F	Embryotoxic	Hearing
22		Phenylmercuric ammonium propionate		F	Embryotoxic	Hearing
22		Phenylmercuric borate		F	Embryotoxic	Hearing
22		Phenylmercuric carbonate		F	Embryotoxic	Hearing
22		Phenylmercuric 2-ethylhexoate; Phenylmercuric octanoate		F	Embryotoxic	Hearing
22		Phenylmercuric formamide		F	Embryotoxic	Hearing
22		Phenylmercuric lactate		F	Embryotoxic	Hearing
22		Phenylmercuric oleate		F	Embryotoxic	Hearing
22		Phenylmercuric propionate		F	Embryotoxic	Hearing
22		Phenylmercuric triethanol ammonium lactate		F	Embryotoxic	Hearing
21	Polyram	Mixture of ammoniate of [Ethylene-bis(dithiocarbamato)]zinc and ethylene-bis[dithiocarbamate]		F	Thyroid cancer	
21		Potassium ammonium ethylene-bisdithiocarbamate	Kaybam	F	Thyroid cancer	
22		Potassium mercuric iodide; Potassium tetraido-mercuriate		F	Embryotoxic	Hearing
25	Promamide	3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)-benzamide	Kerb	H	Cancer	

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
22		Pyridylmercuric acetate		F	Embryotoxic	Hearing
14	Ronnel	0,0-Dimethyl 0-(2,4,5-trichlorophenyl)phosphorothioate	Korlan; Trolene	I	Derived from 2,4,5-T (dioxin)	
11		Safrole		R	Cancer	
23	Silvex	2,4,5-Trichlorophenoxypropionic acid, salts, and esters		H	Dioxin contaminant	Delayed
23		Sodium arsenite; Sodium metaarsenite		H,I	Cancer	Decision under review
99		Sodium ethylmercurithiosalicylate; [0-(Carboxyphenyl)thio]ethyl mercury	Thimersol		Embryotoxic	
12		Sodium pyroarsenate			Cancer	Decision under review
		Sperm oil		I	Endangered species	
11	Strychnine	Strychnine (alkaloids)		R,B,M	Population reduction to non-target organisms	Hearing awaiting further study
11	Strychnine	Strychnine sulfate		R,B,M	Population reduction to non-target organisms	Hearing awaiting further study

PM No.	Common Names	Chemical and Biological Names	Trade and Other Names	Uses	Reason in IV	Status
17	Sulfoxide	1,2-(Methylenedioxy)-4-[2(octylsulfinyl)-propyl]benzene; n-Octyl sulfoxide of isosafrole		I	Cancer	
23	2,4,5-T	2,4,5-Trichlorophenoxyacetic acid, salts and esters		H	Dioxin	Delayed hearing
11		Thallium sulfate		R,M	Population reduction to nontarget organisms	Hearing awaiting further study
25	Tri-allate	S-(2,3,3-Trichloroallyl)diisopropylthiocarbamate	Avadex BW	H	Cancer	
25		S,S,S-Tributyl phosphorotrithioate	Def	X	Delayed neurotoxicity	
16	Trichlorfon	Dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate	Dipterex; Dylox	I	Cancer	
22		2,4,5-Trichlorophenol, and salts		F	Dioxin contaminant	Delayed hearing
21		Zinc mercury chromate			Embryotoxic	Hearing
21	Zineb	Zinc ethylenebisdithiocarbamate		F	Thyroid cancer	

Source: U.S. Environmental Protection Agency, Washington, D.C., February 1976.

EPA SCHEDULE OF PRESUMPTION NOTICE FOR PESTICIDES AND OTHER CHEMICALS

Date	Chemical
August 1976	Endrin, Toxaphene, Strobane, Compound 1080, Strychnine, Lindane
September 1976	Cadmium, DBCP, BHC, Dimethoate, Di-allate, Tri-allate
October 1976	Ethylene dibromide, Trichlorfon, Lead acetate, PCNB, Paraquat, Ethylene oxide
November 1976	EPN, Carbaryl, Arsenicals, Aramite, PCP
December 1976	Creosote, Chloranil, Monuron, Benomyl, 2,4,5-Trichlorophenol, DDVP
January 1977	(SST)DEF, Piperonyl butoxide, Rotenone, Perthane, Safrole, 2,4,5-T and related compounds, Pronamide
February 1977	Merphos, Sperm oil, EBDC

APPENDIX J

CRITERIA FOR SELECTION OF PESTICIDES

The information contained in Appendix J is incorporated into this report to supply additional detail as to the methodology required to select or rank a pesticide active ingredient according to its pollution potential. The information was taken from an EPA document entitled "Production, Distribution, Use and Environmental Impact Potential of Selected Pesticides," by R von Rümker, E. W. Lawless, and A. F. Meiners, EPA 540/1-74-001.

A systematic effort was made to select approximately 25 pesticides for intensive study on this project. A goal was to select major pesticides that would be representative of all the diverse uses of pesticides.

A preliminary rating was made for over 85 pesticides, based on estimated production volume, use patterns, environmental concern and other criteria. These ratings were reviewed with project officers from CEQ and EPA; the weightings of certain criteria were revised slightly, a few new criteria were added, and additional pesticides were suggested.

Approximately 125 pesticides were then divided according to activity type (insecticides, herbicides, etc.) and chemical class and rated with the results shown in Table J-1. A summary of these ratings is shown in Table J-2 and the recommended pesticides are listed in Table J-3. The guidelines for ratings are shown below. At the suggestion of EPA officials the organotin compounds were selected in place of the copper compounds.

GUIDELINES FOR RATING PESTICIDES IN TABLE J-1

Production Rating Scale

Production (mm lb/year AI)	Rating
< 1	0
1-4	+1
5-14	+2
15-29	+3
30-49	+4
50-99	+5
100-200	+6
> 200	+7

Toxicity, Acute LD_{50}	Rating
> 2,000	0
500-2,000	1
50-500	2
< 50	3

TABLE J-1

PESTICIDE PRIORITY RATING

Part A - Insecticides

Characteristic / Rating Scale / Pesticide	Production and Use						Environmental Concern									Regulatory Interest				Other Criteria						
	Production or Import, Total	Ind., Comm., and Inst. Use	Agricultural Use	Governmental Use	Home and Garden Use	Export and Other Use	Toxicity, Mammals, Acute	Toxicity, Special	Toxicity, Birds	Toxicity, Fish	Toxicity, Invert.	Persistence	Biomagnification	Environ. Mobility	Wide Spectrum Activity	Regulation Discussed	Likely to be Cancelled Soon	"Wasteful" Use Pattern	No Available Alternatives	Increased Use Forecast	Decreased Use Forecast	A Leading Product in an Important Group	Group Already Well Represented	Special Consideration	Total	Rank, This Category
	+7	+4	+3	+2	+1	-1	+3	+4	+1	+1	+1	+6	+2	+1	+1	+3	-3	+3	+3	+6	-6	+8	-5	+5		
Toxaphene	5	0	3	0	1	-1	2	0	0	1	0	2	1	0	1	1	0	1	1	3	0	3	0	0	26	2
DDT	4	0	1	0	0	-1	2	0	1	1	0	4	2	1	1	3	-3	2	1	0	-4	2	0	-3	14	
Chlordane	3	1	2	1	1	-1	1	0	0	1	0	4	2	1	1	2	0	2	2	2	0	3	0	0	30	1
Aldrin	2	2	3	0	1	0	2	0	1	1	0	4	2	1	1	3	-3	3	1	0	-3	4	0	0	25	3
Methoxychlor	2	2	1	2	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0	2	0	1	-3	0	12	
Heptachlor	2	1	3	0	0	0	2	0	0	1	0	4	2	1	1	2	0	0	0	0	0	0	-3	0	16	
Dicofol	1	0	1	0	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	-3	0	4	
Endrin	1	1	2	1	0	0	3	0	1	1	0	3	2	1	1	0	-2	0	0	0	0	0	-5	0	10	
Endosulfan	1	0	2	0	0	0	2	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0	-5	0	5	
Chlorobenzilate	1	0	2	0	0	0	1	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	-3	0	5	
Lindane and BHC	1	1	2	0	1	-1	2	0	0	1	0	4	2	1	1	3	0	0	0	0	0	2	-3	0	15	
DDD	0	0	2	0	0	0	0	0	0	1	0	4	2	1	1	3	-2	0	0	0	0	0	-5	0	7	
Dieldrin	0	4	0	0	0	0	2	0	1	1	0	4	2	1	1	3	-3	0	1	0	-1	0	-6	0	12	
Carbaryl	5	1	3	2	1	-1	1	0	0	0	0	0	0	0	1	2	0	0	0	2	0	7	0	0	24	6
Carbofuran	2	0	3	0	0	-1	3	0	1	1	0	0	0	0	1	0	0	0	0	4	0	6	0	0	20	8
Metalkamate	2	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	0	0	13	
Methomyl	1	0	3				3	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	11	
Aldicarb	1	0	3	0	0	0	3	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	-1	-1	9	
Zectran®	1	1	0	1	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	-3	0	5	
Methyl Parathion	4	0	3	0	0	-1	3	0	1	0	1	0	0	0	1	1	0	0	1	4	0	6	0	1	25	4
Malathion	4	3	2	2	1	-1	1	0	0	1	0	0	0	0	1	0	0	0	3	3	0	5	0	0	25	5
Parathion	3	0	3	0	0	-1	3	0	1	1	1	0	0	0	1	1	-1	0	0	1	0	2	0	2	18	10
Diazinon	2	4	2	2	1	0	2	0	1	1	0	1	0	0	1	0	0	0	0	1	0	2	0	0	20	9
Disulfoton	2	0	3	0	1	0	3	0	1	1	0	1	0	0	0	0	0	0	0	1	0	5	0	2	20	7
Phorate	2	0	3	0	0	0	3	0	1	1	0	1	0	0	0	0	0	0	0	0	0	2	-2	0	11	
Monocrotophos	2	0	3	0	0	-1	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	5	
Chlopyrifos	2	2	0	2	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	-2	0	10	
Azinphos-methyl	1	0	3	0	1	0	3	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	-3	0	7	
Fensulfothion	1	0	3	0	0	0	3	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	-3	0	8	
Dyfonate®	1	0	2	0	0	0	3	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	-5	0	4	
Ethion	1	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	1	
[illegible]nnel	1	2	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	4	
Carbophenothion	1	0	3	0	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	4	
Naled	1	1	1	1	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	3	
Dimethoate	1	1	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	2	
Abate®	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	-3	0	1	
Dichlorvos (DDVP)	1	4	0	1	1	0	2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	-2	0	10	
Dicrotophos	1	0	2	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	1	
Prolate	1	0	3	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	7	
Inorganic Arsenates	2	0	3	0	0	0	2	0	0	0	0	4	1	1	0	2	0	0	0	0	-1	4	0	0	18	10

TABLE J-1 (Continued)

Part B - Herbicides

Characteristic Rating Scale Pesticide	Production and Use						Environmental Concern									Regulatory Interest				Other Criteria						
	Production or Import, Total +7	Ind., Comm., and Inst. Use +4	Agricultural Use +3	Governmental Use +2	Home and Garden Use +1	Export and Other Use -1	Toxicity, Mammals, Acute +3	Toxicity, Special +6	Toxicity, Birds +1	Toxicity, Fish +1	Toxicity, Invert. +1	Persistence +4	Biomagnification +2	Environ. Mobility +1	Wide Spectrum Activity +1	Regulation Discussed +3	Likely to be Cancelled Soon -3	"Wasteful" Use Pattern +3	No Available Alternatives +3	Increased Use Forecast +4	Decreased Use Forecast -4	A Leading Product in an Important Group +8	Group Already Well Represented -5	Special Consideration ±5	Total	Rank, This Category
Atrazine	6	1	3	0	1	0	0	0	0	0	0	2	0	1	0	0	0	0	2	2	0	8	0	0	26	1
Simazine	2	4	1	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	4	0	0	15	10
Propazine	1	0	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	0	0	10	
Propachlor	3	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	13	
Alachlor	3	0	3	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	4	0	6	0	0	18	5
CDAA	2	0	3	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	8	
Propanil	2	0	2	0	0	-1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	5	
Diphenamid	1	0	2	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	-2	0	5	
Maleic Hydrazide	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	6	
2,4-D	4	1	3	2	1	-1	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	8	0	0	22	2
2,4,5-T	2	1	2	0	0	-1	2	2	0	0	0	1	0	0	0	3	-1	0	0	0	-2	4	0	-2	11	
Silvex	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	7	
Chloramben	3	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	13	
Dicamba	1	2	2	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	3	0	3	0	0	15	9
2,3,6-TBA	1	2	0	0	0	0	1	0	0	0	0	2	0	0	0	2	0	0	0	0	-2	0	0	0	6	
DCPA	1	0	2	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	1	0	0	8	
Endothall	1	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
Picloram	1	2	1	0	0	-1	0	0	0	0	0	4	0	0	0	1	0	0	0	1	0	0	0	0	9	
Trifluralin	3	0	3	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	3	0	8	0	0	20	4
Dinoseb	1	1	2	1	0	0	3	0	1	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	13	
Nitralin	1	0	2	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	2	0	0	8	
MSMA	3	1	2	0	0	0	1	0	0	0	0	3	1	0	1	3	0	0	0	0	-1	8	0	0	21	3
DSMA	2	0	1	0	0	0	1	0	0	0	0	3	1	0	1	3	0	0	0	0	-1	0	-3	0	8	
Cacodylic Acid	1	1	1	0	0	0	1	0	0	0	0	3	1	0	0	3	0	0	0	0	-2	0	-3	0	5	
Bromacil	2	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	6	0	0	16	7
Diuron	2	3	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	7	0	0	16	8
Fluometuron	1	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	6	
Linuron	1	2	1	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	7	
Norea	1	1	1	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	6	
Butylate	2	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	10	
EPTC	2	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	5	0	0	12	
Vernolate	1	0	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	
Chorpropham	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	-1	0	0	0	3	
Naptalam	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	
TCA	2	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	13	
Dalapon	1	0	0	2	0	-1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	8	
DEF	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	10	
Merphos	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	8	
Chlorate-Borate	4	3	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	-1	8	0	0	18	6
Ammonium Sulfamate	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	8	
Sodium Arsenite	1	1	1	0	0	0	3	0	0	0	0	3	1	0	0	0	0	0	0	0	-1	0	0	0	9	

TABLE J-1 (Continued)

Part C - Fungicides and Wood Preservatives

Characteristic / Rating Scale / Pesticide	Production and Use						Environmental Concern									Regulatory Interest				Other Criteria						
	Production or Import, Total	Ind., Comm., and Inst. Use	Agricultural Use	Governmental Use	Home and Garden Use	Export and Other Use	Toxicity, Mammals, Acute	Toxicity, Special	Toxicity, Birds	Toxicity, Fish	Toxicity, Invert.	Persistence	Biomagnification	Environ. Mobility	Wide Spectrum Activity	Regulation Discussed	Likely to be Cancelled Soon	"Wasteful" Use Pattern	No Available Alternatives	Increased Use Forecast	Decreased Use Forecast	A Leading Product in an Important Group	Group Already Well Represented	Special Consideration	*Total	†Rank, This category
	+7	+4	+3	+2	+1	-1	+3	+4	+1	+1	+1	+4	+2	+1	+1	+3	-3	+3	+3	+4	-4	+8	-5	±5		
Creosote	7	4	1	1	0	0	1	4	0	1	1	2	1	0	1	0	0	1	3	0	0	8	0	1	37	1
Coal Tars	6	4	0	0	0	0	1	4	0	0	0	2	0	0	0	1	0	1	2	0	0	4	-5	0	20	7
Petroleum Oils	6	3	2	0	0	0	0	0	0	1	0	2	0	0	1	0	0	1	2	0	0	2	-3	0	17	10
Inorganic Sulfur	6	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	15	
Inorganic Coppers	4	2	2	1	0	0	2	0	0	1	0	2	0	1	0	0	0	0	0	0	0	8	0	0	21	5
Organo Coppers	1	3	1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	-3	0	5	
Organo Tins	1	3	2	0	0	0	2	0	0	1	1	3	2	0	0	0	0	0	0	1	0	4	0	0	20	6
Mercurials	0	3	0	0	1	0	3	0	1	1	1	4	2	1	1	3	-3	0	0	0	-3	4	0	-2	17	10
Chromates	2	4	0	0	0	0	2	1	0	0	0	3	0	0	0	0	0	0	0	1	0	4	0	0	17	10
Pentachlorophenol	3	4	0	0	1	0	2	4	0	0	1	3	0	0	0	0	0	0	3	1	0	8	0	0	32	2
Trichlorophenol	3	4	0	0	0	0	1	3	0	0	0	2	0	0	0	0	0	0	1	1	0	4	0	0	19	8
Pentachloronitro Benzene	1	2	2	0	0	0	1	1	0	0	0	1	0	0	0	2	0	0	1	0	0	2	0	0	13	
Captan	3	0	3	0	1	0	0	2	0	0	0	0	0	0	0	2	0	0	1	2	0	8	0	0	22	3
Captafol	1	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	10	
Folpet	1	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	8	
Maneb	2	0	3	0	1	-1	0	4	0	0	0	1	0	0	0	3	0	0	0	1	0	8	0	0	22	4
Metham	2	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	10	
Zineb	1	0	3	0	1	-1	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	12	
Ziram	1	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	
Ferbam	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Nabam	1	0	1	0	1	0	2	4	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	
Niacide®	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Polyram	1	0	2	0	0	0	J	4	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0		10	
Thiram	1	1	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	10	
PETD	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Dodine	1	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0	12	
Benomyl	2	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0	12	
Dinocap	0	0	2	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7	

TABLE J-1 (Concluded)

Part D - Fumigants

Characteristic / Rating Scale / Pesticide	Production and Use						Environmental Concern									Regulatory Interest				Other Criteria					
	±7 Production or Import, Total	+4 Ind., Comm., and Inst. Use	±3 Agricultural Use	±2 Governmental Use	±1 Home and Garden Use	±1 Export and Other Use	±3 Toxicity, Mammals, Acute	±4 Toxicity, Special	±1 Toxicity, Birds	±1 Toxicity, Fish	±1 Toxicity, Invert.	±4 Persistence	±2 Biomagnification	±1 Environ. Mobility	±1 Wide Spectrum Activity	±3 Regulation Discussed	-3 Likely to be Cancelled Soon	±3 "Wasteful" Use Pattern	±3 No Available Alternatives	±4 Increased Use Forecast	-4 Decreased Use Forecast	+8 A Leading Product in an Important Group	-5 Group Already Well Represented	±2 Special Consideration	Total	Rank, This Category
Dichlorobenzene	5	3	1	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	5	0	+1	21	1
Methyl Bromide	3	2	2	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	1	0	8	0	0	20	2
Dichloropropane-Propane	3	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	13	4
Ethylene Dibromide	3	3	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	14	3
Dibromochloropropane	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	7	
Carbon Disulfide-Tetrachloride	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
Ethylene Dichloride	2	2	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	-3	0	4	
Dichloronitroethane	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
Naphthalene	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
Ethylene Oxide-Carbon Dioxide	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Aluminum Phosphide	0	4	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	12	5
Calcium Cyanide	0	1	1	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	-1	0	0	0	5	
Sulfuryl Fluoride	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	6	

TABLE J-2

SUMMARY OF RATINGS

Group Rank	Insecticides	Total	Herbicides	Total	Fungicides and Preservatives	Total	Fumigants	Total
1	Chlordane	30	Atrazine	26	Creosote	37	Dichlorobenzene	21
2	Toxaphene	26	2,4-D	22	PCP	32	Methyl Bromide	20
3	Aldrin	25	MSMA	21	Captan	22	Ethylene Dibromide	14
4	Methyl Parathion	25	Trifluralin	20	Maneb	22	Dichloropropene-propane	13
5	Malathion	25	Alachlor	18	Inorganic Coppers	21	Aluminum Phosphide	12
6	Carbaryl	24	Chlorates	18	Organo Tins	20		
7	Disulfoton	20	Bromacil	16	Coal Tars	20		
8	Carbofuran	20	Diuron	16	TCP	19		
9	Diazinon	20	Dicamba	15	Chromates, Petroleum Oils, Mercurials (Tie)	17		
10	Inorganic Arsenates Parathion (Tie)	18	Simazine	15				

TABLE J-3

PESTICIDES RECOMMENDED FOR STUDY

	Pesticide	Rating Total	Type
1	Creosote	37	F
2	Pentachlorophenol	32	F
3	Chlordane	30	I
4	Toxaphene	26	I
5	Atrazine	26	H
6	Aldrin	25	I
7	Methyl Parathion	25	I
8	Malathion	25	I
9	2,4-D	24	H
10	Carbaryl	24	I
11	Captan	22	F
12	Maneb	22	F
13	MSMA	21	H
14	Dichlorobenzene	21	Fu
15	Methyl Bromide	20	Fu
16	Trifluralin	20	H
17	Diazinon	20	I
18	Disulfoton	20	I
19	Carbofuran	20	I
20	Parathion	18	I
21	Alachlor	18	H
22	Chlorates	18	H
23	Bromacil	16	H
24	Diuron	16	H
25	Copper or organotin compounds	(21)a/	F

I - Insecticide; H - Herbicide; F - Fungicide; Fu - Fumigant.

a/ The copper (and similarly the tin, chromium and mercury) fungicides require special consideration because no single chemical compound is involved.

Toxicity, Special

Carcinogenic, teratogenic or mutagenic properties of the pesticide or its impurities reported.

Toxicity

Toxicity to birds, fish or invertebrates resulting from normal use patterns.

Persistence

The following scale has been used where possible, but persistence varies with conditions and data are often unavailable.

Time (months for 75-100%) Disappearance	Rating
< 1	0
1-3	1
3-10	2
10-18	3
> 18	4

Biomagnification, wide spectrum activity and the categories under regulatory interest are largely self-explanatory. The "no alternatives available" implies that no effective, economical substitute pest-control method is now available for one or more major uses of the named pesticide.

The "increased" and "decreased use forecast" columns consider restrictions on competitive products and regulatory actions as well as normal market potential.

The column, "A leading product is an important group," considers not only the chemical class but also the use pattern. The highest rating is given to a product that is a leading example of an important group in which no single member is otherwise highly rated.

Special Considerations

DDT--

The decision to cancel most uses of DDT in the U.S. has already been made by EPA in a special ruling.

Aldicarb--

Pure aldicarb is the most toxic of major pesticides, but is marketed only as a 10% granular formulation.

Methyl parathion--

The substitution of methyl parathion for the less toxic DDT on cotton has necessitated a farm worker retraining program.

Disulfoton--

This product is especially representative of a large class of very toxic agricultural insecticides.

Parathion--

The reentry controversy requires special considerations.

2,4,5-T--

The production of 2,4,5-T has dropped greatly since its military use was halted and in addition, presently produced material contains little or none of the objectionable chloro-dioxins formerly produced as an impurity.

Creosote--

The environmental aspects of this heavily used pesticide have been little studied. Much creosote-treated wood is placed in close contact with water.

Mercurials--

The objectionalbe use of alkyl mercury fungicides for seed treatment has been cancelled.

Dichlorobenzene--

Much of this chlorinated hydrocarbon is placed directly into wastewater via lavatory use* and into the air we breathe at home and at work. Studies of the environmental aspects are negligible to date, and the conventional method used for analysis of chlorinated hydrocarbon pesticides in water does not normally detect dichlorobenzene. It has, however, been detected in the blood of workers exposed to it regularly and appears to accumulate in fatty tissues like other chlorinated hydrocarbons.

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* A fundamental question of the definition of the word pesticide is raised when one considers the lavatory use of dichlorobenzene (e.g., does it kill organisms that cause odors?). Disinfectants are increasingly listed with pesticides in some government statistics.

APPENDIX K

ALTERNATIVE METHODOLOGY FOR SELECTING PLANT SITES

This section of the report presents an alternate methodology and associated information base which could be used to select the best plant sites for detailed source assessment. The methodology used entailed both a subjective and objective approach to the problem. Once the major subjective assumptions had been made and the known objective criteria had been assembled, the number of pesticide plants was reduced to 25 candidates using a rating system developed for this study. A "least number" of candidate plants that would give a suitable sample for source assessment was then sought from this group using further subjective and objective considerations. The "least number" of plants selected was 12. Those plants are:

1. Monsanto, Anniston, Alabama
2. Montrose, Torrance, California
3. Hercules, Brunswick, Georgia
4. Eli Lilly, Lafayette, Indiana
5. Monsanto, Muscatine, Iowa
6. Ciba-Geigy, St. Gabriel, Louisiana
7. Dow, Midland, Michigan
8. American Cyanamid, Linden, New Jersey
9. Stauffer, Perry, Ohio
10. Du Pont, LaPorte, Texas
11. Union Carbide, Institute and South Charleston, West Virginia
12. Ansul, Marinette, Wisconsin

Although these 12 plants are believed to be representative of the air emissions problems and controls of the entire pesticide industry, we must emphasize that the wide range of production processes leaves any small sample inadequate to some degree.

The discussion which follows shows in detail how and why these 12 plants were chosen and is divided into the following sections.

- Selection Methodology: A Subjective and Objective Approach
- Estimated Total Production and Toxicity Rating of Pesticides by Chemical Group

- Identification of Pesticide Manufacturers and the Rating System
- Selection and Discussion of the 25 Best Candidate Pesticide Plants
- Selection of the Least Number of Candidate Pesticide Plants

METHODOLOGY: A SUBJECTIVE AND OBJECTIVE APPROACH

The methodology used to select individual candidate pesticide plants involves both a subjective and an objective approach. The subjective assumptions are valid only in general. Because the pesticide industry is very diverse in production processes, pollution control technologies, chemical input materials, chemical process equipment, and other important parameters which affect the pollution potential of a given plant, the subjective assumptions will not be true in every case.

The subjective approach to the selection of individual candidate pesticide plants makes assumptions about the relative pollution potential of one plant in comparison to other plants. The only parameters considered in the assumptions are those for which quantitative data are currently available. The major subjective assumptions made in this analysis are:

- A pesticide plant has a greater pollution potential as the total volume of pesticides produced at that plant increases.
- A pesticide plant has a greater pollution potential as the number of different individual active ingredients produced increases.
- The greater the toxicity of the pesticide(s) produced at a pesticide plant, the more serious the pollution potential of that plant.

The assumptions are used to determine which plants have the greatest pollution potential and therefore, are the best candidates for detailed source assessment.

The objective approach to the selection of individual pesticide plants compares plants to each other on the basis of the currently available quantitative data on both manufacturers and formulators. The criteria which have been quantified are:

- Total estimated production volumes of the major pesticides.
- Toxicity of individual pesticides.
- Chemical classification of the pesticides.

- Identification of plant sites which manufacture pesticides and of plant sites which manufacture the major pesticides.

- Number of individual pesticides and number of individual major pesticides produced at each plant.

Unfortunately few or no quantitative data are available for the approximately 5,600 pesticide formulation plants in the United States. No information is available on the volume of pesticide products formulated at each plant, or on the type of pesticide products which are formulated at each plant.* Without this information, it is virtually impossible to select two or three representative candidate plants for detailed source assessment. In addition, the pesticide formulation industry is so diverse with respect to types of pesticide products formulated, process equipment and techniques employed, and other important criteria that source assessment of one or more plants, selected on the basis of available data, would reveal very little about the pollution problems of this major segment of the pesticide industry.

Therefore, the pesticide plants selected in this study for detailed source assessment are all manufacturers of the active pesticide ingredients. Even this selection poses a considerable problem since about 140 manufacturing plants are currently operating, and many of these plants would be good candidates for detailed source assessment.

The methodology used to select the candidate plants relies on the three subjective assumptions and the five quantitative criteria given above. First, the estimated production volume, toxicity rating, and chemical group designations of the major pesticides are given. Second, the 139 pesticide manufacturing plants and the 73 pesticide manufacturing plants which produce the major pesticides are identified; and the number of individual pesticides and number of individual major pesticides produced at each plant are given. These statistics are used to rank the priority of assessing each plant in a rating system developed for this study. Third, the best 25 candidate plants determined from the rating system and the minor pesticides produced at each plant are listed. Finally, the least number (12) of plants are selected from the group of 25 taking into consideration all of the quantitative data given and subjective assumptions made, as well as other considerations where appropriate.

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* Information on the types and quantities of pesticides formulated by each formulation plant are being submitted to EPA in accordance with Section 7 of the 1972 Amendments of the Federal Insecticide, Fungicide, and Rodenticide Act. However, this information has not been made available to the MRI project team.

The detailed methodology used in this study is examined in the following discussions.

ESTIMATED TOTAL PRODUCTION AND TOXICITY RATING OF PESTICIDES BY CHEMICAL GROUP

The first important consideration in selecting individual candidate pesticide plants is to select those plants which produce the pesticides made in the largest quantities, the most toxic pesticides, and the pesticides representative of the pesticide industry. Therefore, the first step in the selection process is to review the quantitative data on the pesticides themselves.

Table K-1 summarizes data previously given in this report. The table shows the estimated 1974 U.S. production of major individual synthetic organic pesticides and the toxicity rating of each pesticide. In addition, the pesticides are presented in 11 separate groups (with subdivisions for the organophosphates and carbamates). Ten of these groups (A through J) contain individual pesticides that are similar in chemical composition and that are produced by similar production techniques. The 11th group (K) is a miscellaneous category. The pesticides listed in Table K-1 are those that are produced in the largest quantities in each group, and shall hereafter be referred to as the "major pesticides."

The toxicity rating for each pesticide is derived from the toxicity data previously given. These ratings were determined as shown in Table K-2.

One important point should be noted regarding Table K-1. In Group H, the usage of chlordane, aldrin, endrin, and heptachlor have recently been restricted in the United States. Current and future production of pesticides in this group will probably be low due to current EPA restrictions on pesticides in this group unless a suitable export market exists.

IDENTIFICATION OF PESTICIDE MANUFACTURERS AND THE RATING SYSTEM

The list of pesticide manufacturers operating in 1975 is given in Table K-3. This list shows 139 pesticide manufacturing plants and is, to the best of our knowledge, complete. Each plant listed is given both by location and by company ownership. This table also shows the number of individual active ingredients produced at each plant, the number of major pesticides produced at each plant, and the rating of each plant. All of the information in the table, except the ratings, was obtained from SRI (1976).

Table K-4 , based upon SRI (1976) data, was constructed to show which plants and how many produce the major pesticides. This table shows that 73 plants produce the major pesticides, that 26 major pesticides are produced at only one plant, and that 30 of the plants produce more than one major pesticide.

Table K-1. ESTIMATED U.S. PRODUCTION AND TOXICITY RATINGS OF MAJOR INDIVIDUAL SYNTHETIC ORGANIC PESTICIDES, BY CATEGORY, IN 1974

Group designation	Chemical group	Pesticide	Estimated 1974 production (million lb)	Approximate percentage of production in each group	Toxicity rating
A	Chlorinated hydrocarbons	Toxaphene	110	24	2
		DDT	60[a]	13	2
		2,4-D acid, esters, salts	55[b]	12	2
		PCP and sodium salts	52[c]	11	3
		Trichlorophenols	25	6	1
		Dichloropropene	24	6	2
		Chloramben	22	5	1
		DBCP	20	4	2
		Sodium TCA	15	3	1
		All others	77	16	-
			460	100	
B	Organophosphates				
	(1) Phosphates	Monocrotophos	7	4	3
	(2) Phosphorothioates	Methyl parathion	51[c]	25	4
		Parathion	17	9	4
		Diazinon	12	6	2
		Fensulfothion	6	3	4
	(3) Phosphorodithioates	Malathion	30	15	1
		Disulfoton	10	5	3
		Phorate	10	5	4
		Merphos	5	2	2
		All others	52	26	-
			200	100	
C	Carbamates				
	(1) Carbamates	Carbaryl	58	39	2
		Bux®	10	7	2
		Carbofuran	10	7	3
		Methomyl	10	7	3
		Aldicarb	5	3	4
		Benomyl	4	2	0
	(2) Thiocarbamates	Butylate	8	5	1
		EPTC	6	4	1
		Vernolate	5	3	1
	(3) Dithiocarbamates	Maneb	12	8	1
		Zineb	7	5	1
		Nabam	5	3	2
		All others	10	7	-
			150	100	
D	Triazines	Atrazine	110	73	1
		Simazine	15	10	1
		Propazine	10	7	0
		All others	15	10	-
			150	100	
E	Anilides	Propachlor	45	41	1
		Alachlor	40	36	1
		Propanil	15	14	1
		Butachlor	10	9	1
			110	100	
F	Organoarsenicals and organometallics	MSMA	35	64	-
		DSMA	10	18	1
		Cacodylic acid	3	5	1
		Copper naphthenates	2[c]	3	1
		All others	5	10	-
			55	100	

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Table K-1 (concluded)

Group designation	Chemical group	Pesticide	Estimated 1974 production (million lb)	Approximate percentage of production in each group	Toxicity rating
G	Other nitrogenous compounds	Captan	20	29	2
		CDAA	7	10	1
		Maleic hydrazide	6[c]	9	1
		Nitralin	3	4	1
		Picloram	3	4	1
		Captafol	3	4	1
		Folpet	3	4	0
		All others	25	36	-
			70	100	
H	Diene-based	Chlordane	15[d]	38	2
		Aldrin	10[e]	25	3
		Endrin	3	7	4
		Heptachlor	3[d]	7	3
		Endosulfan	3	7	3
		All others	6	16	-
			40	100	
I	Ureas and uracils	Bromacil	12	30	1
		Diuron	10	25	2
		Fluometuron	5	13	2
		Linuron	3	7	1
		Terbacil	3	7	0
		All others	7	18	-
			40	100	
J	Nitrated hydrocarbons	Trifluralin	25	63	2
		Chloropicrin	5[c]	13	2
		Dinoseb	3	7	3
		Benefin	3	7	1
		All others	4	10	-
			40	100	
K	All others	Methyl bromide	31[c]	30	-
		Miscellaneous	71	70	-
			102	100	
	Total all synthetic organic pesticides		1,417[c]		

Source: MRI estimates (February 1976)

[a] Based upon DDT exports of 56.4 million pounds (100% basis) in 1974 as reported in The Pesticide Review, 1974 (1975).

[b] Based upon report in Chemical Marketing Reporter, January 5, 1976.

[c] Based upon data published by U.S. International Trade Commission (1975).

[d] Based upon report in Chemical Marketing Reporter, July 14, 1975.

[e] Based upon report in Chemical Marketing Reporter, April 14, 1975.

Table K-2. PESTICIDE TOXICITY RATINGS

Rating	Classification	Oral LD_{50} - rats (mg/kg)
0	Insignificantly toxic	Above 5,000
1	Slightly toxic	500-5,000
2	Moderately toxic	50-500
3	Highly toxic	5-50
4	Extremely toxic	Below 5

Table K-3. PLANT LOCATION, COMPANY OWNERSHIP, NUMBER OF PESTICIDES PRODUCED, AND RATING FOR EACH PESTICIDE MANUFACTURING PLANT IN THE U.S. IN 1975

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Anniston, AL	Monsanto	2	2	5
Cold Creek, AL	Stauffer	9	3	5
McIntosh, AL	Olin	2	0	0
Mobile, AL	Shell	4	1	4
Oxford, AL	Tull	1	0	0
El Dorado, AR	Great Lakes	2	2	4
Jacksonville, AR	Transvaal	16	2	5
Brea, CA	Thompson-Hayward	2	0	0
Fremont, CA	Am-Chem	10	1	4
Long Beach, CA	Niklor	1	1	1
Long Beach, CA	Tenneco	1	0	0
Monrovia, CA	Pennwalt	1	0	0
Pittsburg, CA	Dow	2	2	4
Richmond, CA	Chevron	4	1	4
Richmond, CA	Stauffer	2	0	0
Torrance, CA	Montrose	1	1	5
Trona, CA	Kerr-McGee	1	1	1
Boulder, CO	Syntex	1	0	0
Denver, CO	Alpha	1	0	0
Denver, CO	ASARCO	1	0	0
Denver, CO	Shell	9	5	5
Bethel, CT	R. T. Vanderbilt	1	1	1
Naugatuck, CT	Uniroyal	1	0	0

Table K-3 (continued)

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Stamford, CT	Northeast Pharmaceutical	1	1	1
New Castle, DE	Witco	1	0	0
Orlando, FL	Chevron	2	0	0
Brunswick, GA	Hercules	1	1	5
Chicago, IL	Glenn	1	0	0
Chicago, IL	Nor-Am	7	1	3
Chicago, IL	Ventron	1	0	0
Chicago Heights, IL	Riverdale	10	1	4
Marshall, IL	Northwest Industries	1	1	1
North Chicago, IL	Abbott Labs	4	0	0
Sauget, IL	Monsanto	3	1	5
East Chicago, IN	Du Pont	2	1	2
Lafayette, IN	Eli Lilly	6	2	5
Clinton, IA	Am-Chem	1	0	0
Ft. Madison, IA	Chevron	1	1	5
Muscatine, IA	Monsanto	4	4	5
Shenandoah, IA	Imperial	1	1	1
Kansas City, KS	PBI-Gordon	7	1	3
Kansas City, KS	Thompson-Hayward	5	1	3
Pittsburg, KS	Gulf Oil	2	0	0
Wichita, KS	Vulcan	1	1	3
Carrolton, KY	M&T Chemical	1	0	0
Geismar, LA	Uniroyal	2	1	1
Luling, LA	Monsanto	2	0	0

Table K-3 (continued)

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Norco, LA	Shell	1	1	3
Plaquemine, LA	Hercules	2	0	0
St. Gabriel, LA	Ciba-Geigy	16	5	5
St. Gabriel, LA	Stauffer	3	2	4
Orrington, ME	Sobin	1	1	1
Baltimore, MD	FMC	3	0	0
Curtis Bay, MD	Diamond Shamrock	1	0	0
Midland, MI	Dow	28	7	5
St. Louis, MI	Northwest Industries	1	1	1
Wyandotte, MI	Pennwalt	2	1	1
Minneapolis, MN	McLaughlin Gormley King	10	0	4
Hamilton, MS	Kerr-McGee	1	1	3
Vicksburg, MS	Vicksburg	3	2	4
Cadet, MO	Buckman Labs	2	0	0
Kansas City, MO	Chemagro	21	2	5
Maryland Heights, MO	Chevron	2	0	0
St. Joseph, MO	Am-Chem	10	1	4
St. Louis, MO	Mallinckrodt	2	0	0
St. Louis, MO	Monsanto	1	0	0
Henderson, NV	Stauffer	1	0	0
Bayonne, NJ	White	1	0	0
Berkley Heights, NJ	Kewanee	1	0	0
Clark, NJ	MOTOMCO	3	0	0
Clifton, NJ	Cosan	3	0	0

Table K-3 (continued)

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Edison, NJ	Blue Spruce	13	6	5
Elizabeth, NJ	Tenneco	4	0	0
Fords, NJ	Tenneco	4	1	4
Great Meadows, NJ	Ashland Oil	2	0	0
Hawthorne, NJ	Merck	5	0	0
Linden, NJ	American Cyanamid	6	2	5
Linden, NJ	Du Pont	3	0	0
Lyndhurst, NJ	S. B. Penick	3	0	0
Montville, NJ	S. B. Penick	7	0	3
Newark, NJ	Fairmount	1	1	1
Newark, NJ	Prentiss Drug	9	3	5
Newark, NJ	Sobin	1	1	1
Newark, NJ	Troy	7	0	3
New Brunswick, NJ	Rhodia	6	0	3
Somerset, NJ	Rhodia	7	1	3
Somerset, NJ	W. A. Cleary	8	1	3
South Plainfield, NJ	Chevron	2	0	0
Vineland, NJ	Vineland	9	3	5
Wood Ridge, NJ	Ventron	13	0	4
Woodbridge, NJ	American Cyanamid	1	0	0
Albany, NY	Chempar	1	0	0
Ardsley, NY	Stauffer	3	0	0
Central Islip, NY	McKenzie	1	0	0
Niagara Falls, NY	Occidental	8	1	3

Table K-3 (continued)

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Middleport, NY	FMC	10	3	5
Gastonia, NC	Uniroyal	1	0	0
Greensboro, NC	Pfizer	1	0	0
Raleigh, NC	Mallinckrodt	1	0	0
Barberton, OH	PPG	2	0	0
Bedford, OH	Ferro	1	0	0
Dover, OH	Dover	1	1	3
Perry, OH	Chevron	2	2	4
Perry, OH	Stauffer	3	2	5
Portland, OR	Chempar	6	1	3
Ambler, PA	Am-Chem	22	2	5
Bristol, PA	Rohm and Haas	2	0	0
Danville, PA	Merck	1	0	0
Delaware Water Gap, PA	Heico	1	0	0
Eighty Four, PA	West Chemical	1	0	0
Hanover, PA	Alco	1	0	0
Philadelphia, PA	Rohm and Haas	8	3	5
State College, PA	Nease	1	0	0
Elgin, SC	Hardwicke	2	0	0
Chattanooga, TN	Northwest Industries	1	0	0
Memphis, TN	Buckman Labs	2	0	0
Memphis, TN	Northwest Industries	3	2	0
Mt. Pleasant, TN	Mobil	3	1	4
Mt. Pleasant, TN	Stauffer	3	2	4

Table K-3 (concluded)

Plant location	Company	No. of pesticides produced	No. of pesticides in Table K-1 produced	Rating
Bayport, TX	Northwest Industries	1	0	0
Beaumont, TX	Northwest Industries	1	0	0
Deer Park, TX	Shell	1	1	3
Freeport, TX	Dow	3	2	5
Greens Bayou, TX	Diamond Shamrock	4	2	4
Groves, TX	Riverside	1	1	3
Houston, TX	Sonford	1	0	0
LaPorte, TX	Du Pont	8	6	5
Texas City, TX	GAF	1	1	3
Hopewell, VA	Allied	1	0	0
Portsmouth, VA	Virginia Chemical	1	0	0
Tacoma, WA	Reichhold	3	1	2
Vancouver, WA	FMC	1	1	1
Belle, WV	Du Pont	1	1	4
Nitro, WV	Chemical Formulators	5	1	3
Nitro, WV	Fike	4	1	2
Nitro, WV	Monsanto	2	0	0
Institute and South Charleston, WV	Union Carbide	2	2	5
Marinette, WI	Ansul	5	4	5
Milwaukee, WI	Aldrich	1	0	0

The information presented in Tables K-3 and K-4 was used to develop a rating system for this study to give a priority ranking for the pesticide manufacturing plants as candidates for detailed source assessment. The rating system was constructed so that the plants which are selected for source assessment are characterized by the following features.

- They produce the pesticides with the largest total volume.
- They produce the greatest total number of individual pesticides.
- They produce pesticides in as many of the 11 groups as possible.

Thus, the final selection of candidate plants aims at choosing plants which represent the large volume pesticides, the largest number of individual pesticides, and the largest variety of pesticides by chemical class.

The important variables considered in the rating system, then, and the effect these variables have on the rating of a plant are:

- The number of individual pesticides produced at a plant. The more pesticides produced, the higher the rating.
- The number of major pesticides produced at a plant. The more major pesticides produced, the higher the rating.
- The number of plants which produce a given pesticide. The greater the number of plants which produce a given pesticide, the lower the rating for those plants which produce that pesticide when considering that pesticide alone.
- The total production volume of the pesticides produced by the industry. The higher the total volume of a pesticide produced by the industry, the higher the rating of a plant which produces that pesticide.

Each of these variables was considered in constructing a rating scale from 0 to 5 with 5 as the highest priority rating. Each plant was given a rating as shown in Table K-1, and these ratings were generally determined as follows:

Rating	Criteria
0	Plant produces fewer than five pesticides and produces no major pesticides.
1	Plant produces one pesticide which is a major pesticide whose estimated total annual production is less than 10 million pounds at that plant. The pesticide is produced by other plants which produce more pesticides than the subject plant.

LOCATION AND COMPANY NAME OF PESTICIDE PRODUCERS THAT MANUFACTURED THE MAJOR SYNTHETIC ORGANIC PESTICIDES, IN EACH GROUP, IN 1971

		Plant location and company name of pesticide producers																																		
	Number of production plants	Anniston, AL - Monsanto	Cold Creek, AL - Stauffer	St. Gabriel, LA - Ciba-Geigy	Mobile, AL - Shell	El Dorado, AR - Great Lakes	Jacksonville, AR - Transvaal	Fremont, CA - Am-Chem	Long Beach, CA - Witco	Pittsburg, CA - Dow	Richmond, CA - Chevron	Torrance, CA - Montrose	Trona, CA - Kerr-McGee	Denver, CO - Shell	Bethel, CT - R. T. Vanderbilt	Stamford, CT - ME Pharmaceutical	Brunswick, GA - Hercules	Chicago, IL - Nor-Am	Chicago Hts., IL - Riverdale	Marshall, IL - MW Industries	Sauget, IL - Monsanto	East Chicago, IN - Du Pont	Lafayette, IN - Eli Lilly	Ft. Madison, IA - Chevron	Muscatine, IA - Monsanto	Shenandoah, IA - Imperial	Kansas City, KS - PBI-Gordon	Kansas City, KS - Thompson-Hayward	Wichita, KS - Vulcan	Geismar, LA - Uniroyal	Norco, LA - Shell	St. Gabriel, LA - Stauffer	Orrington, ME - Sobin	Midland, MI - Dow	St. Louis, MI - MI Industries	Wyandotte, MI - Pennwalt
Group A																																				
Toxaphene	6																X																			
DDT	1											X																								
2,4-D acid, esters, salts	11						X	X											X							X	X	X						X		
PCP and sodium salts	5																				X								X					X		
Trichlorophenols	3						X									X																		X		
Dichloropropene	3																														X					
Chloramben	2																																			
DBCP	3				X									X																				X		
Sodium TCA	1																																	X		
Group B																																				
(1) Monocrotophos	1													X																						
(2) Methyl parathion	3	X																																		
Parathion	2	X																																		
Diazinon	2			X																																
Fensulfothion	1																																			
(3) Malathion	3																																			
Disulfoton	1																																			
Phorate	1																																			
Merphos	1																																			
Group C																																				
(1) Carbaryl	1																																			
Bux	1																							X												
Carbofuran	2																																			
Methomyl	2													X																						
Aldicarb	1																																			
Benomyl	1																																			
(2) Butylate	2		X																													X				
EPTC	2		X																													X				
Vernolate	1		X																																	
(3) Maneb	3																																			
Zineb	4																																			
Nabam	2																																			X
Group D																																				
Atrazine	2			X																																
Simazine	1			X																																
Propazine	1			X																																
Group E																																				
Propachlor	1																								X											
Alachlor	1																								X											
Propanil	3																																			
Butachlor	1																								X											
Group F																																				
MSMA	3																																			
DSMA	4																																			
Cacodylic acid	2																																			
Group G																																				
Captan	3														X																					
CDAA	1																								X											
Maleic hydrazide	4																													X						
Nitralin	1													X																						
Picloram	2									X																										
Captafol	1										X																									
Folpet	2																																			
Group H																																				
Chlordane	2																			X																
Aldrin	1													X																						
Endrin	1																																			
Heptachlor	1																																			
Endosulfan	2																																			
Group I																																				
Bromacil	1																																			
Diuron	1																																			
Fluometuron	2			X														X																		
Linuron	2																					X														
Terbacil	1																																			
Group J																																				
Trifluralin	1																						X													
Chloropicrin	4					X			X	X																							X			
Dinoseb	3																																	X		
Benefin	1																						X													
Group K																																				
Methyl bromide	4					X							X																					X	X	
Total Pesticides, in list, produced at each plant		2	3	5	1	2	2	1	1	2	1	1	1	5	1	1	1	1	1	1	1	1	2	1	4	1	1	1	1	1	1	2	1	7	1	1
Total all pesticides produced at each plant		2	9	16	4	2	16	10	1	2	4	1	1	9	1	1	1	7	10	1	3	2	6	1	4	1	7	5	1	2	1	3	1	20	1	2

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Table [illegible] (Concluded)

	Number of production plants
Group A	
Toxaphene	6
DDT	1
2,4-D acid, esters, salts	11
PCP and sodium salts	3
[illegible]	3
[illegible]	3
[illegible]	2
[illegible]	3
[illegible]	1
Group B	
(1) [illegible]	1
(2) Methyl parathion	3
Parathion	2
Diazinon	2
[illegible]	1
(3) Malathion	3
[illegible]	1
[illegible]	1
[illegible]	1
Group C	
(1) Carbaryl	1
[illegible]	1
Carbofuran	2
[illegible]	2
Aldicarb	1
[illegible]	1
(2) [illegible]	3
[illegible]	1
[illegible]	1
(3) Maneb	3
Zineb	4
Nabam	2
Group D	
Acrolein	2
[illegible]	1
[illegible]	1
Group E	
Propachlor	1
Alachlor	1
Propanil	3
[illegible]	1
Group F	
MSMA	3
DSMA	4
Cacodylic acid	2
Group G	
Captan	3
[illegible]	1
Maleic hydrazide	4
[illegible]	1
Picloram	2
Captafol	1
Folpet	2
Group H	
Chlordane	2
[illegible]	1
[illegible]	1
[illegible]	1
Endosulfan	2
Group I	
[illegible]	1
[illegible]	1
[illegible]	1
[illegible]	2
Terbacil	1
Group J	
Trifluralin	1
[illegible]	4
[illegible]	3
[illegible]	1
Group K	
Methyl bromide	6

Total pesticides, in list, produced at each plant: 1 2 2 1 6 1 2 1 3 1 1 1 3 1 3 [illegible]

Total all pesticides produced at each plant: 1 3 21 10 13 6 6 1 9 1 7 8 9 9 10 [illegible]

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Rating	Criteria
2	Plant produces two to four pesticides, and one major pesticide whose total annual production is less than 10 million pounds. The major pesticide is produced by other plants which either produce other major pesticides or produce a greater number of pesticides than the subject plant.
3	(a) Plant produces five or more pesticides and one major pesticide whose total annual production is less than 10 million pounds. The major pesticide is produced by other plants which produce other major pesticides also.
	(b) Plant produces one to three pesticides, and one is a major pesticide whose total annual production exceeds 10 million pounds. The major pesticide is produced by other plants which produce more of the major pesticide or more total major pesticides than the subject plant.
	(c) Plant produces five to nine pesticides and no major pesticides.
4	(a) Plant is the sole producer of one major pesticide whose total annual production is less than 10 million pounds. Plant may produce other pesticides also.
	(b) Plant produces two major pesticides, and each major pesticide is either produced by plants with a 5 rating or has an annual production of less than 10 million pounds and is produced by other plants also.
	(c) Plant produces four or more pesticides and one major pesticide whose total annual production is greater than 10 million pounds. The major pesticide is produced by other plants also.
	(d) Plant produces 10 or more pesticides and no major pesticides.
5	(a) Plant is the sole producer of one (or more) major pesticides whose total annual production exceeds 10 million pounds.
	(b) Plant produces two or more major pesticides and at least one of the major pesticides has an annual production exceeding 10 million pounds.
	(c) Plant produces three or more major pesticides and is the sole producer of one or more of the major pesticides.
	(d) Plant produces one major pesticide and is the only plant which produces that pesticide in excess of 20 million pounds.

SELECTION AND DISCUSSION OF THE 25 BEST CANDIDATE PESTICIDE PLANTS

The 25 best candidate pesticide plants for detailed source assessment were selected by the rating system just described. Table K-3 shows that 25 plants received a rating of 5, and these plants are the best candidates of the 139 plants listed based upon the data available and the methodology used in this study.

The objective in this section is to compare the 25 plants to each other so that a minimum number of plants emerge as the best candidates of this group. The best plants selected should produce the high volume pesticides, the most toxic pesticides, the greatest number of pesticides, and pesticides which are members of as many of the 11 chemical groups as possible. Obviously, some trade-offs must be made to limit the number of plants selected.

In order to select the least number of plants from the group of 25, further analysis and description of each plant is requisite so that the relative merits of each plant may be compared to the others. These descriptions give a list of the minor (or other) pesticides produced at each plant, the chemical group each of the minor pesticides is a member of, and the number of other plants which produce each minor pesticide. (Note: Minor pesticides, as used here, are all pesticides not listed in Table K-1.) The major pesticides produced at each plant have already been described in detail in Tables K-1 and K-4.

Each plant is listed separately below, and the minor pesticides produced at each plant are described.

1. Monsanto, Anniston, Alabama

Minor pesticides: None

2. Stauffer, Cold Creek, Alabama

Minor pesticides	Group	No. of other producers
Carbophenthion (Trithion®)	B_3	0
Bensulide (Prefar®)	B_3	0
Cycloate (Ro-Neet®)	C_2	0
Molinate (Ordram®)	C_2	0
Dyfonate®	B_3	0
Pebulate (Tillam®)	C_2	0

3. Transvaal, Jacksonville, Arkansas

Minor pesticides	Group	No. of other producers
2,4-DP	A	0
2,4-D, n-butoxyethyl ester	A	3
2,4-D, n-butyl ester	A	9
2,4-D, N,N-dimethyloleyl linoleylamine salt	A	0
2,4-D, iso-octyl ester	A	9
2,4-D, isopropyl ester	A	3
2,2-dichloropropionic acid	A	0
2,4,5-T	A	1
2,4,5-T, n-butoxyethyl ester	A	3
2,4,5-T, n-butyl ester	A	2
2,4,5-T, N,N-dimethyloleyl linoleylamine salt	A	0
2,4,5-T, iso-octyl ester	A	7
2,4,5-T, triethylamine salt	A	2
Silvex	A	1

4. Montrose, Torrance, California

Minor pesticides: None

5. Shell, Denver, Colorado

Minor pesticides	Group	No. of other producers
Bladex®	D	0
Dichlorvos (Vapona®)	B_1	1
Bidrin®	B_1	0
Mevinphos (Phosdrin®)	B_1	1
Ciodrin®	B_1	0

6. Hercules, Brunswick, Georgia

Minor pesticides: None

7. Monsanto, Sauget, Illinois

Minor pesticides	Group	No. of other producers
Santophen I®	A	1

8. Eli Lilly, Lafayette, Indiana

Minor pesticides	Group	No. of other producers
Dipropalin	J	0
Diphenylacetonitrile	G	1
Chloroethylmercury	F	0
Piperalin (Pipron®)	G	0

9. Chevron, Fort Madison, Iowa

Minor pesticides: None

10. Monsanto, Muscatine, Iowa

Minor pesticides: None

11. Ciba-Geigy, St. Gabriel, Louisiana

Minor pesticides	Group	No. of other producers
Prometryne (Caprol®)	D	0
Igran 80 W®	D	0
Chlorazine (Princep® 80 W)	D	0
Cloroxuron (Tenoran®)	I	1
Chlorophenamidine	G	1
Preforan®	J	0
Atratrone	D	0
Ametryne (Evik®)	D	0
Chlorobenzilate	A	0
Acaralate®	A	0
Prometone (Pramitol®)	D	0

12. Dow, Midland, Michigan

Minor pesticides	Group	No. of other producers
Ruelene®	B	0
Dinoseb, alkanolamine salt	J	0
2,4-D, n-butoxyethyl ester	A	3
2,4-D, butoxypolypropyleneglycol ester	A	0
2,4-D, butoxy propyl ester	A	0
2,4-D, sec-butyl ester	A	1
2,4-D, dimethylamine salt	A	8
2,4-D, ethanolamine and isopropanolamine salts	A	0
2,4-D, iso-octyl ester	A	9
2,4-D, isopropyl ester	A	3
2,4-D, sodium salt	A	1
Dalapon®	A	0
Chlorpyrifos (Dursban®)	B_2	0
Mexacarbate (Zectran®)	C_1	0
Ronnel (Korlan®)	B_2	0
2,4,5-T	A	1
2,4,5-T, sodium salt	A	0
2,4,5-T, butoxyethanol ester	A	0
2,4,5-T, butoxypolypropyleneglycol ester	A	0
Silvex	A	1

13. Chemagro, Kansas City, Missouri

Minor pesticides	Group	No. of other producers
Sencor®	D	0
Gophacide®	B	0
Chlonitralid (Bayluscide®)	J	0
Dyrene®	D	0
Coumaphos (Co-Ral®)	B_2	0
Demeton (Systox®)	B_2	0
Azinphosmethyl (Guthion®)	B_3	0
Fenthion (Baytex®)	B_2	0
Fenitrothion	B_2	0
Methiocarb (Mesurol®)	C_1	0
Monitor®	B	0
Chlorphos (Dylox®)	B_1	0
Ediphenos (Hinosan®)	B_3	0
Methyl demeton (Meta-Systox®)	B_2	0
Morestan®	G	0
Propoxur (Baygon®)	C_1	0
Dexon®	G	0
DEF®	B	0
Fenamiphos	B	0

14. Blue Spruce, Edison, New Jersey

Minor pesticides	Group	No. of other producers
2-(2-butoxyethoxy)ethyl thiocyanate	K	1
Dinoseb, triethanolamine salt	J	1
DNOC	J	0
DNOC, sodium salt	J	0
Thanite	K	2
Rotenone	K	5
Warfarin	K	3

15. American Cyanamid, Linden, New Jersey

Minor pesticides	Group	No. of other producers
Famphur (Warbex®)	B_2	0
Dimethoate (Cygon®)	B_3	0
Polyacrylonitrile, hydrolyzed, sodium salt	G	1
Abate®	B_2	0

16. Prentiss Drug, Newark, New Jersey

Minor pesticides	Group	No. of other producers
Lindane	H	1
Thiodiphenylamine	G	1
Pyrethrum	K	3
Rotenone	K	5
Methoxychlor	A	2
Warfarin	K	3

17. Vineland, Vineland, New Jersey

Minor pesticides	Group	No. of other producers
Bis-1,4-bromoacetoxy-2-butene	K	0
Cacodylic acid, sodium salt	F	0
Methanearsonic acid, calcium acid salt	F	0
Methanearsonic acid, dodecyl- and octyl-ammonium salts	F	1
Methylarsine oxide	F	0
Methylarsine sulfide	F	0

18. FMC, Middleport, New York

Minor pesticides	Group	No. of other producers
Dinoseb, ammonium salt (Sinox® General)	J	0
Dinoseb, triethanolamine salt (Sinox® PE)	J	1
Dichlone	A	0
Ferbam	C_3	1
Karbutilate (Tandex®)	C_1	0
Polyram (Polyram®)	C_3	0
Rotenone	K	5

19. Stauffer, Perry, Ohio

Minor pesticides	Group	No. of other producers
PMM	K	0

20. Am-Chem, Ambler, Pennsylvania

Minor pesticides	Group	No. of other producers
Chloramben, ammonium salt	A	3
Amitrole	G	1
Amex 820	G	0
Ethrel®	B_1	0
Bromoxynil, octanoic acid ester	A	0
2,4-DB, dimethylamine salt	A	0
2,4-D, n-butoxyethyl ester	A	3
2,4-D, n-butyl ester	A	9
2,4-D, dimethylamine salt	A	8
2,4-D, iso-octyl ester	A	9
Coumafuryl	K	2
Cantrol	A	1
NAA	K	0
Rootone®	G	0
NAA, ethyl ester	K	0
NAA, sodium salt	K	0
2,3,6-TBA, dimethylamine salt	A	2
2,4,5-T, n-butoxyethyl ester	A	3
Fenac®	A	2
TIBA	A	1

21. Rohm and Haas, Philadelphia, Pennsylvania

Minor pesticides	Group	No. of other producers
Perthane®	A	0
Pronamide	A	0
Nitrofen (Tok®)	J	0
Dicofol (Kelthane®)	A	0
Karathane®	J	1

22. Dow, Freeport, Texas

Minor pesticides	Group	No. of other producers
Amitrole (Tordon®)	G	1

23. Du Pont, LaPorte, Texas

Minor pesticides	Group	No. of other producers
Monuron (Telvar®)	I	0
Metam	C_3	3

24. Union Carbide, Institute and South Charleston, West Virginia

Minor pesticides: None

25. Ansul, Marinette, Wisconsin

Minor pesticides	Group	No. of other producers
Naptalam	G	1

All of the information on the 25 plants presented to this point is summarized in Table K-5 for convenient reference. Table K-5 lists each of the 25 plants and shows the following information.

- The pesticides which have an estimated annual production of 25 million pounds or more and the plants which produce those pesticides.

- The major pesticides which are either extremely toxic (4 toxicity rating) or highly toxic (3 toxicity rating), and the plants which produce those pesticides.

- The 11 chemical groups and plants which produce major pesticides in those groups, and the plants which produce minor pesticides in those groups.

Table K-5. SUMMARY OF IMPORTANT CHARACTERISTICS OF EACH OF THE 25 BEST CANDIDATE PESTICIDE PLANTS FOR DETAILED SOURCE ASSESSMENT

Plant	Largest volume pesticides											Most toxic pesticides												No. of major pesticides produced in pesticide groups											No. of minor pesticides produced in pesticide groups										
	Toxaphene	Atrazine	DDT	Carbaryl	2,4-D	PCP	Methyl parathion	Methyl bromide	Malathion	Trifluralin	Trichlorophenols	Methyl parathion	Parathion	Phorate	Fensulfothion	Aldicarb	PCP	Disulfoton	Carbofuran	Methomyl	Monocrotophos	Dinoseb	Endosulfan	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	I	J	K
Monsanto, Anniston, AL							X					X	X												2																				
Stauffer, Cold Creek, AL																										3										3	3								
Transvaal, Jacksonville, AR					X						X													2											14										
Montrose, Torrence, CA			X																					1																					
Shell, Denver, CO																				X	X			1	1	1				1						4		1							
Hercules, Brunswick, GA	X																							1																					
Monsanto, Sauget, IL						X											X							1											2										
Eli Lilly, Lafayette, IN										X																							2							1	2			1	
Chevron, Ft. Madison, IA																										1																			
Monsanto, Muscatine, IA																												3		1															
Ciba-Geigy, St. Gabriel, LA		X																							1		3					1			2			6			1		1	1	
Dow, Midland, MI					X	X		X			X						X					X		5									1	1	16	3	1							1	
Chemagro, Kansas City, MO															X			X							2											12	2	2			2			1	
Blue Spruce, Edison, NJ									X													X			1	3		1					1											3	4
American Cyanamid, Linden, NJ									X					X											2											3					1				
Prentiss Drug, Newark, NJ									X																2										1						1	1			3
Vineland, Vineland, NJ																													3											5					1
FMC, Middleport, NY																			X				X			2					1		1		1		3							2	1
Stauffer, Perry, OH																														2															1
Am-Chem, Ambler, PA					X																			2											12	1					3				4
Rohm and Haas, Philadelphia, PA																										2		1							3									2	
Dow, Freeport, TX																								1						1											1				
Du Pont, LaPorte, TX																				X						2						4					1						1		
Union Carbide, Institute and				X												X										2																			
South Charleston, WV																													3	1											1				
Ansul, Marinette, WI																																													

This table is important to the selection of the least number of candidate plants from this group of 25, and this selection is made in the next section.

SELECTION OF THE LEAST NUMBER OF CANDIDATE PESTICIDE PLANTS

All of the 25 plants given in the previous section are excellent candidates for detailed source assessment. The objective of this section of the report is to eliminate as many of the plants in this group as possible to reduce the amount of effort required to perform a suitable assessment of the pollution problems of the pesticide manufacturing industry. At the same time, however, the group of pesticide plants selected must be representative of this industry.

For a suitable representative sample of plants, the following criteria must be met.

- All pesticides produced in annual quantities in excess of 25 million pounds should be produced at the selected plants.
- All 11 chemical groups should be adequately represented in the plant selection. Pesticides which constitute at least 30% of the annual production volume in each chemical group should be manufactured at the selected plants. (This excludes Group H, since the major pesticides in this group have restrictions upon their usage and the current production volume of this group is very low.)
- Most of the extremely and highly toxic major pesticides should be produced at the selected plants.

Plants are first selected that produce the large volume pesticides; then plants are selected to fill the gaps these large volume pesticide producers leave in the chemical groups. (Some of the groups have no pesticides whose annual production volume exceeds 25 million pounds--namely, Groups G, H, and I.) Finally, the most toxic pesticides are reviewed to see how many of them are produced by the plants selected by the first two criteria.

Large Volume Pesticide Representation

Table K-5 indicates that the 11 large volume (25 million pounds annually or more) pesticides can be sampled by selecting as a minimum these plants.

- Hercules, Brunswick, Georgia (toxaphene).
- Ciba-Geigy, St. Gabriel, Louisiana (atrazine).
- Montrose, Torrance, California (DDT).

- Union Carbide, Institute and South Charleston, West Virginia (carbaryl).
- Dow, Midland, Michigan (2,4-D; PCP; methyl bromide; trichlorophenols).
- Monsanto, Anniston, Alabama (methyl parathion).
- American Cyanamid, Linden, New Jersey (malathion).
- Eli Lilly, Lafayette, Indiana (trifluralin).

All eight of these plants are selected as candidates for source assessment in this study for the following reasons.

Hercules, Brunswick, Georgia--

Hercules is the largest producer of toxaphene in the United States. Three other plants produce toxaphene in annual amounts of about 10 million pounds each, whereas Hercules produces about 75 to 80 million pounds annually. None of the other three plants is in the group of 25, and to exclude Hercules from the selection would exclude toxaphene, the largest volume pesticide in the United States (along with atrazine).

Ciba-Geigy, St. Gabriel, Louisiana--

Ciba-Geigy is the sole producer of atrazine, as well as the sole producer of simazine and propazine, and cannot be excluded from consideration without excluding these three important pesticides, which constitute 90% of the production volume in Group D, the triazines, and have an estimated combined annual production of 135 million pounds.

Montrose, Torrance, California--

Montrose is the sole producer of DDT, and therefore this plant must be selected to examine the pollution potential of the manufacture of this high volume (60 million pounds annual production) pesticide.

Union Carbide, Institute and South Charleston, West Virginia--

Union Carbide is the sole producer of carbaryl and aldicarb. Carbaryl represents about 40% of the total annual production of carbamates (Group C), and aldicarb is the most toxic major pesticide in the carbamate group. Union Carbide cannot be excluded without excluding these two important pesticides.

Dow, Midland, Michigan--

Dow produces four major pesticides that have a combined annual production of about 160 million pounds, produces two other major pesticides (DBCP and dinoseb) that have a combined annual production of about 23 million pounds, and is the sole producer of sodium TCA that has an estimated annual production volume of 15 million pounds. This Dow plant also produces 21 minor pesticides (12 of which are produced only at this plant) that fall into four different chemical groups.

Dow produces more major pesticides (7) and more minor pesticides (21) than any other plant in the United States. This plant cannot be excluded from consideration without substantially reducing the validity of a source assessment study.

Monsanto, Anniston, Alabama--

Monsanto produces the extremely toxic pesticides parathion and methyl parathion. The combined annual production of these pesticides is about 70 million pounds or about 35% of the total annual organophosphate production (Group B). Due to the high volume and high toxicity of these pesticides, a valid source assessment program should include examination of these pesticides.

Monsanto has the largest capacity (50 million pounds annually) in the pesticide industry to produce both parathion and methyl parathion and is chosen as the best plant for studying the pollution potential of the manufacture of these pesticides.

American Cyanamid, Linden, New Jersey--

American Cyanamid is one of three plants which produce malathion and is the sole producer of phorate, an extremely toxic organophosphate pesticide. Malathion is produced in an estimated quantity of 30 million pounds and phorate is produced in an estimated quantity of 10 million pounds. These two pesticides represent 20% of the total annual organophosphate production.

American Cyanamid is chosen over the Blue Spruce, Edison, New Jersey, and Prentiss Drug, Newark, New Jersey, plants, which are the other producers of malathion, since the American Cyanamid plant has the largest capacity for organophosphates (in our estimation) among these plants and is the sole producer of phorate.

Eli Lilly, Lafayette, Indiana--

Eli Lilly is the sole producer of trifluralin and benefin, two nitrated hydrocarbon pesticides (Group J). The combined annual production of these two pesticides is about 28 million pounds or 70% of the total annual production in Group J. This plant cannot be excluded without excluding trifluralin with an annual estimated production of 25 million pounds and at the same time excluding the major pesticides in Group J.

The next discussion examines the chemical group criteria and adds plants to the select list as needed to fulfill the requirement of sampling enough plants for an adequate representation of each of the chemical groups.

Chemical Group Representation

A detailed source assessment of the above eight selected plants will give suitable and representative data of Groups A, B, C, D, J, and K. These plants, however, will reveal little about Groups E, F, G, and I. (Group H is excluded because there are restrictions on the major pesticides in this group and volume of production is currently low.)

Group E, the anilides, can be adequately assessed by examining only one plant--Monsanto, Muscatine, Iowa. Monsanto is the sole producer of propachlor, alachlor, and butachlor. These three pesticides are produced in a total estimated annual quantity of 95 million pounds or about 86% of the total annual production volume of anilides. Therefore, Monsanto, Muscatine, Iowa, is added to the select list to give a representative assessment of Group E.

Group F, the organoarsenicals and organometallics, can be adequately assessed by examining either Ansul's plant at Marinette, Wisconsin, or Vineland's plant at Vineland, New Jersey. Both plants produce MSMA, DSMA, and cacodylic acid. These three pesticides are produced in an estimated total annual volume of 48 million pounds or about 87% of the total pesticide production in this group.

The choice between these two plants is close and either of them would be suitable candidates. Ansul is selected since it produces one other major pesticide, maleic hydrazide, and this pesticide is in Group G. Thus, Ansul, Marinette, Wisconsin, is added to the select list to represent Group F.

Group G, other nitrogenous compounds, contains only one pesticide which is produced in excess of 10 million pounds annually--captan, 20 million pounds. This pesticide and folpet, another member of this group, are produced by only two plants and only one of these plants is in the list of 25 selected plants. That plant is Stauffer, Perry, Ohio. Therefore, Stauffer, Perry, Ohio, is added to the select list to help give a representative assessment of Group G.

Group I, ureas and uracils, can be adequately assessed by examining Du Pont's plant at LaPorte, Texas. This plant is the sole producer of bromacil, diuron, and terbacil, and is one of two producers of linuron. These four pesticides are produced in an estimated total quantity of 28 million pounds or about 70% of the total annual production of ureas and uracils. Therefore, Du Pont, LaPorte, Texas, is added to the select list to give a representative assessment of Group I.

The third criterion, assessing most of the extremely and highly toxic pesticides, is discussed next.

Extremely and Highly Toxic Pesticide Representation

The 12 major pesticides which have a toxicity rating of 4 (extremely toxic) or 3 (highly toxic) are listed in Table K-5. This table shows that the 12 plants selected to this point produce seven of those toxic pesticides, which is a suitable number for the purpose of this study. To assess more of these toxic pesticides would require adding more plants, which cannot be justified on toxicity alone. Therefore, no plants are added to the select list in an effort to gain a larger sample of the 12 highly toxic major pesticides listed in Table K-5.

In summary, the minimum number of plants that must be subjected to a detailed source assessment to give a reasonable picture of the pollution problems in the pesticide manufacturing industry is 12. These plants are:

- Monsanto, Anniston, Alabama
- Hercules, Brunswick, Georgia
- Eli Lilly, Lafayette, Indiana
- Monsanto, Muscatine, Iowa
- Ciba-Geigy, St. Gabriel, Louisiana
- Dow, Midland, Michigan
- American Cyanamid, Linden, New Jersey
- Stauffer, Perry, Ohio
- Du Pont, LaPorte, Texas
- Union Carbide, Institute and South Charleston, West Virginia
- Ansul, Marinette, Wisconsin
- Montrose, Torrance, California

Assessing these 12 plants will provide information on many of the major pesticides, numerous minor pesticides, and give a good representative sample of the pesticides in each chemical group.